FEDERAL AVIATION REGULATIONS

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION—WASHINGTON, DC

CHANGE 1 EFFECTIVE: OCTOBER 17, 1994

Part 27—Airworthiness Standards: Normal Category Rotorcraft

This change incorporates Amendment 27–29, Airworthiness Standards; New Rotorcraft 30-Second/2-Minute One-Engine-Inoperative Power Ratings, adopted September 9, 1994. This amendment revises §§ 27.923, 27.1143, 27.1305, 27.1521, and 27.1549.

Bold brackets enclose the most recently changed or added material in these particular sections. The amendment number and effective date of new material appear in bold brackets at the end of each affected section.

Page Control Chart

Remove Pages	Dated	Insert Pages	Dated
P–305	—	P–305 through P–310	Ch. 1
Subpart E	—	Subpart E	Ch. 1
Subpart F	—	Subpart F	Ch. 1
Subpart G	—	Subpart G	Ch. 1

Suggest filing this transmittal at the beginning of the FAR. It will provide a method for determining that all changes have been received as listed in the current edition of AC 00–44, Status of Federal Aviation Regulations, and a check for determining if the FAR contains the proper pages.

over a 10-year period, the total annualized cost due to the rule would be $675, which is less than the $4,100 threshold. A small commercial operator would exceed the annual cost threshold only if the operator replaced at least 9 part 29 rotorcraft with 12 seats (or 3 part 29 rotorcraft with 45 seats). This is very unlikely. Furthermore, even if this did occur among all operators with 8 or 9 part 29 rotorcraft with more than 12 seats, it would represent only 15 commercial operators or 8.4 percent of the 178 commercial operators. The rule, therefore, does not impact more than one-third of affected small entities. Thus, even in the worst case, the final rule would not substantially impact a significant number of small entities.

Federalism Implications

The regulations adopted herein will not have substantial direct effects on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government. Therefore, in accordance with Executive Order 12612, it is determined that this final rule does not have sufficent federalism implications to warrant the preparation of a Federalism Assessment.

Conclusion

For these reasons, and based on the findings in the Regulatory Flexibility Determination and the International Trade Impact Assessment, the FAA has determined that this regulation is not major under Executive Order 12291. In addition, the FAA certifies that these amendments do not have a significant economic impact, positive or negative, on a substantial number of small entities under the criteria of the Regulatory Flexibility Act. These amendments are considered nonsignificant under DOT Regulatory Policies and Procedures (44 FR 11034, February 26, 1979.) A regulatory evaluation of the amendments, including a Regulatory Flexibility Determination and an International Trade Impact Assessment, has been placed in the docket. A copy may be obtained by contacting the person identified under "FOR FURTHER INFORMATION CONTACT."

Adoption of the Amendments

Accordingly, parts 21, 27, 29, and 91 of the Federal Aviation Regulations (14 CFR parts 21, 27, 29 and 91) are amended effective September 16, 1991.

The authority citation for part 27 continues to read as follows:

Authority: 49 U.S.C. 1344, 1354(a), 1355, 1421, 1423, 1425, 1428, 1429, 1430; 49 U.S.C. 106(g).

Amendment 27–29

Airworthiness Standards; New Rotorcraft 30-Second/2-Minute One-Engine-Inoperative Power Ratings

Adopted: September 9, 1994 **Effective: October 17, 1994**

(Published in 59 FR 47764, September 16, 1994)

SUMMARY: This rule adopts new and revised airworthiness standards by incorporating optional one-engine-inoperative (OEI) power ratings for multiengine, turbine-powered rotorcraft. These amendments result from a petition for rulemaking from Aerospace Industries Association of America (AIA) and the recognition by both government and industry that additional OEI power rating standards are needed. These amendments enhance rotorcraft safety after an engine failure or precautionary shutdown by providing higher OEI power, when necessary. These amendments also assure that the drive system will maintain its structural

By letter dated September 28, 1984, the AIA petitioned for rulemaking by requesting amendments to parts 1, 27, 29, and 33 of the Federal Aviation Regulations (FAR) to establish new 30-second, 2-minute, and continuous OEI power ratings.

In the process of drafting the amendments, numerous meetings were held with the industry groups and airworthiness authorities of other countries in an attempt to identify and address all of the issues. As set forth in the AIA's petition, only multiengine rotorcraft, with turbine-powered engines, would be eligible for these new OEI power ratings which would be applicable to the remaining engine(s) only after an in-flight failure or precautionary engine shutdown. The rated 30-second OEI power would be limited to periods of not more than 30 seconds at any one time and would enhance the OEI performance of the rotorcraft during the transient phase of the takeoff and landing maneuvers. The rated 2-minute OEI power would be limited to periods of not more than 2 minutes at any one time and would achieve initial stabilized climb of at least 100 feet per minute following takeoff or balked landing flight with one engine inoperative. These ratings could be used instead of the existing 2-1/2-minute OEI power rating or normal takeoff power.

The continuous OEI power rating and all aspects of its definition, eligibility, qualification, and performance credit were adopted in Amendments 1–34, 27–23, 29–26, and 33–12, Rotorcraft Regulatory Review Program Amendment No. 3 (53 FR 34198, September 2, 1988).

This final rule is based on Notice of Proposal Rulemaking (NPRM) No. 89–26 that was published in the *Federal Register* on September 22, 1989 (54 FR 39086). A corresponding NPRM, Notice No. 89–27, that proposed changes to parts 1 and 33 for definitions and engines was also published in the same issue of the *Federal Register* (54 FR 39080). In addition, a joint public meeting was held on November 16, 1989, in Fort Worth, Texas, to discuss both notices (54 FR 41986).

All interested persons have been given an opportunity to participate in this rulemaking and due consideration has been given to all matters presented. Some minor editorial changes have been made to clarify the proposals. The changes are based on comments received and further FAA review of the proposals. Except as indicated herein, the proposals contained in the notice have been adopted without change.

Discussion of Comments

The commenters represented airframe manufacturers, airworthiness authorities from other countries, rotorcraft owners and operators, and private individuals. The commenters generally agree with the substance of the proposal with certain recommended changes. The following discussion addresses these recommendations and their disposition.

Sections 27.923 and 29.923 Rotor drive system and control mechanism tests.

The notice proposed changes to §§ 27.923(e) and 29.923(a) and (b) that add the special tests to the rotor drive system endurance test schedule, which are necessary to qualify the rotor drive system for the new 30-second/2-minute OEI power ratings.

One commenter, referring to §§ 27.923(e)(2)(i) and 29.923(e)(3)(i), states that if the 5-minute takeoff power run to qualify the drive system is conducted as part of the endurance run, and the 30-second/2-minute OEI requirements are conducted on a bench test, then the takeoff power 5-minute run will be conducted twice on the same set of gears. The commenter proposes that the wording for the bench testing requirements be changed to state ". . . following stabilization at takeoff power." The FAA does not intend to duplicate the takeoff power 5-minute run and agrees that clarification is needed; therefore, the recommended change has been incorporated.

Another commenter recommends doubling the test time in § 29.923(b)(3)(i) because the drive system, at the higher and potentially more damaging 30-second/2-minute OEI power ratings, will be substantiated by less endurance testing at these new powers. This recommendation is beyond the scope of the notice. Further, the FAA disagrees with the recommendation to double the test time for drive system substantiation

and 29.923(b)(3)(iii). The FAA disagrees because the preferred method of conducting the tests is on the rotorcraft where the entire drive system is subjected to the OEI powers. Since the FAA recognizes that in some cases it may not be possible to conduct these tests on the rotorcraft, a bench test, which is representative of the aircraft, is included as an acceptable alternative.

Another commenter proposes to clarify §§ 27.923(e)(2)(iii) and 29.923(b)(3)(iii) by inserting the word "vibration" between the words "the" and "frequency." The FAA agrees, and the change has been made.

Other than some minor editorial changes, these amendments are adopted as discussed.

Sections 27.1143 and 29.1143 Engine controls.

The notice proposed to include the requirement for automatic control of the 30-second OEI power in §§ 27.1143(e) and 29.1143(f). One commenter suggests that § 29.1143(f) is ambiguous in that it does not adequately define the meaning of "control." The FAA agrees that additional clarification is necessary. The amendment now states, ". . . automatically activate and control the 30-second OEI power and prevent. . . ." Other than this clarification, the amendments are adopted as proposed.

Sections 27.1305 and 29.1305 Powerplant instruments.

The notice proposed to include the requirements for a pilot alert and a recording device when 30-second/2-minute OEI powers are used by adding paragraphs (t) and (u) to § 27.1305 and paragraphs (a)(24) and (25) to § 29.1305.

One commenter proposes to add the words ". . . for use by ground personnel . . ." between the words "provided" and "which" in §§ 27.1305(u) and 29.1305(a)(25). The FAA agrees, and the change has been made.

Another commenter states that because of the number of warnings being introduced by § 29.1305(a)(24), some guidance material is needed. The FAA agrees and will address these concerns with forthcoming advisory material.

A third commenter suggests adding the word "automatically" before the word "records" in § 29.1305(a)(25)(i). The FAA agrees, and the amendments are adopted with the changes.

Sections 27.1521 and 29.1521 Powerplant limitations.

The notice proposed to add paragraphs (j) and (k) to § 27.1521 and paragraphs (i) and (j) to § 29.1521 to include the 30-second/2-minute OEI power limitations, along with rotorcraft applicability and the conditions for their use. One commenter supports this proposal if the amendments to parts 1 and 33 ensure mandatory maintenance of the engine following use of the 30-second OEI power rating. In addition, the commenter further states that the transmission and gearbox should not be subject to mandatory maintenance. The testing requirements proposed in §§ 27.923 and 29.923 for the 30-second/2-minute OEI power ratings will minimize the need for mandatory maintenance of the transmission and gearbox following application of the 30-second/2-minute OEI power in service. The amendments, which concern the airframe requirements, are adopted without change.

Sections 27.1549 and 29.1549 Powerplant instruments.

The notice proposed to revise §§ 27.1549(e) and 29.1549(e) by defining the instrument markings associated with the 30-second/2-minute OEI power ratings. One commenter supports the proposal and suggests that some guidance material is needed. The FAA agrees, and guidance material will be developed. These amendments are adopted as proposed.

which certification is requested. The amendment is adopted without change.

Additional Discussion

Training

Although outside the scope of this rulemaking, the FAA has recognized the need for additional training for flight crewmembers in the correct procedures and use of these new OEI power ratings. A commenter notes that the use of these new ratings could result in serious damage to the operating engine and that additional training must be available to satisfy the operational and airworthiness needs. The FAA agrees, and these training procedures will be considered by operations specialists during the certification process.

Power Assurance

A commenter notes that power assurance requirements, as given in §§ 27.45(f) and 29.45(f), will be affected by these amendments and recommends the issuance of guidance material. The FAA recognizes the importance of the power assurance requirement for approval and use of these new OEI power ratings, and appropriate guidance material will be developed.

Limiting Height-Speed Envelope

One commenter asks whether the 30-second power is the ''greatest power for which certification is requested'' as currently contained in §§ 27.79(b)(2) and 29.79(b)(1). For these amendments, 30-second power is the greatest power for which certification could be accomplished.

Airworthiness Limitations Section

One commenter addressed the need for changes to Appendix A33.4, Airworthiness Limitations Section. Since this comment addresses part 33, it will be handled in the rulemaking effort underway addressing that part.

Regulatory Evaluation Summary

Regulatory Evaluation

This section summarizes the full regulatory evaluation prepared by the FAA that provides more detailed estimates of the economic consequences of this regulatory action. This summary and the full evaluation quantify, to the extent practicable, estimated costs to the private sector, consumers, and Federal, State and local governments, as well as anticipated benefits.

Executive Order 12866 dated September 30, 1993, directs Federal agencies to promulgate new regulations and maintain current regulations only if they are required by law, are necessary to interpret the law, or are made necessary by a ''compelling public need.'' The order also requires that agencies assess all costs and benefits of available regulatory alternatives and select the alternative that maximizes the net benefits and imposes the least burden on society.

Additionally, the order requires agencies to submit a list of all rules, except those specifically exempted by the Office of Information and Regulatory Affairs (OIRA) because they respond to emergency situations or other narrowly defined exigencies, to determine if the rules constitute ''significant regulatory action.'' ''Significant regulatory action'' means an action that is likely to result in a rule that may (1) have an annual effect on the economy of $100 million or more or adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or state, local, or tribal governments or communities; (2) create a serious inconsistency or otherwise interfere with an action taken or planned by another agency; (3) materially alter the budgetary impact of entitlements, grants, user fees, or loan programs or the rights and obligations of recipients thereof; or (4) raise novel legal or policy issues arising out of legal mandates, the President's priorities, or

The use of the new optional rating structure will provide significant benefits to operators of Category A helicopters. Category A helicopters are multiengine, can withstand any single engine becoming inoperative, and can continue safe flight or landing within a demonstrated field size. In addition to increased payloads, the amendments will enable rotorcraft operators to operate from significantly smaller heliports with the same degree of safety because of the decrease in the minimum required rejected takeoff distance for Category A operations. The rejected takeoff distance is the distance from the start of the takeoff to the stopping point after landing. The current regulation puts operators using shorter fields at a disadvantage because of the inability to satisfy Category A operational requirements. This increased operational flexibility should enable them to fly Category A operations and possibly use more efficient and profitable route structures (where larger fields are not available).

The rule establishes OEI ratings for periods of shorter duration than previously allowed and will provide an additional optional capability to manufacturers. The testing costs associated with obtaining these ratings should be viewed as the price of an additional capability and will be evaluated by the individual rotorcraft manufacturers based on market potential. The principal operational benefit of these new optional ratings is the ability to carry higher payloads from existing fields or to takeoff from smaller fields with current payloads. The AIA estimates that the use of the new rating structure for a given Category A mission could result in an increase in productivity of 48 percent for a 37,000-pound design gross weight (DGW) helicopter, and up to 125 percent for a 7,500-pound DGW helicopter if operators who fly only Category A missions choose to take full advantage of the increase in payload that will be permitted. The AIA further notes that the public will also benefit from these changes because the availability of viable, short-field performance should encourage the development of downtown heliports, thereby enhancing convenience.

For a manufacturer considering a new design, the issue of whether to design a helicopter to accommodate engines capable of satisfying the new OEI rating scheme (use of the new ratings will affect helicopter performance standards as well as the structural and drive system requirements) will be influenced by the following factors:

- The availability of appropriately sized engines (larger helicopters designed for Category A use will be able to use a smaller engine).
- The OEI capability of competitive products.
- The operator mission requirements.
- The cost (for increased testing and increased engine performance) of obtaining the new OEI capability compared to the benefit derived from the increase in payload or flexibility of route structures afforded by this capability.

The availability of the new OEI capability could provide substantial benefits to rotorcraft manufacturers and operators. However, such benefits are difficult to quantify because the number of products certificated to this standard cannot be estimated. In addition, the specific increase in dispatch payload cannot be estimated because it will depend on the specific rotorcraft design in relation to the engines that will be available. These optional ratings should enhance the ability of operators who are limited by current regulations to Category B operations, because of the small size fields they use to fly more Category A operations, which should improve their profitability. The extent of these benefits cannot be predicted since they will depend, to a large degree, on the mix of Category A and B operations that are chosen. The FAA has not been able to quantify these potential benefits either on a per-unit or industry-wide scale due to the changes in rotorcraft design and performance that these optional ratings could promote and the large number of highly variable factors that would influence the magnitude of the overall benefits. The FAA concludes that the optional OEI ratings will not have a negative impact on manufacturers or operators. Since these ratings are optional, manufacturers will provide this capability only if the additional costs can be recovered in the market place.

The Regulatory Flexibility Act of 1980 (RFA) was enacted by Congress to ensure that small entities are not unnecessarily and disproportionately burdened by government regulations. The RFA requires agencies to review rules that may have "a significant economic impact on a substantial number of small entities." The FAA's criteria for a small aircraft manufacturer is one employing fewer than 75 employees. A substantial number is a number that is not fewer than 11 and is more than one-third of the small entities subject to the rule. A significant impact is one having an annual cost of more than $14,900 (1987 dollars) per manufacturer.

A review of domestic helicopter manufacturing companies indicates that there are fewer than eleven small helicopter manufacturers. Therefore, the amendments to parts 27 and 29 will not affect a substantial number of small entities.

Trade Impact Analysis

The rule changes will have little or no impact on trade for both U.S. firms doing business in foreign countries and foreign firms doing business in the United States. In the U.S. market, foreign manufacturers will have the option of designing engines and helicopters capable of satisfying the new OEI ratings and, therefore, will not be at a competitive disadvantage with U.S. manufacturers. Because of the large U.S. market, foreign manufacturers are likely to certificate their rotorcraft to U.S. rules, which will limit any competitive advantage U.S. manufacturers might gain in foreign markets.

Federalism Implications

The regulations adopted herein will not have substantial direct effects on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government. Therefore, in accordance with Executive Order 12612, it is determined that this final rule does not have sufficient federalism implications to warrant the preparation of a Federalism Assessment.

Conclusion

For the reasons discussed in the preamble, and based on the findings in the Regulatory Flexibility Determination and the Trade Impact Analysis, the FAA has determined that this regulation is not a significant regulatory action under Executive Order 12866. In addition, the FAA certifies that these amendments do not have a significant economic impact, positive or negative, on a substantial number of small entities under the criteria of the Regulatory Flexibility Act. These amendments are considered nonsignificant under DOT Regulatory Policies and procedures (44 FR 11034; February 26, 1979). A regulatory evaluation of the amendments, including a Regulatory Flexibility Determination and Trade Impact Analysis, has been placed in the docket. A copy may be obtained by contacting the person identified under "FOR FURTHER INFORMATION CONTACT."

Adoption of the Amendments

Accordingly, parts 27 and 29 of the Federal Aviation Regulations (14 CFR parts 27 and 29) are amended effective October 17, 1994.

The authority citation for part 27 continues to read as follows:

Authority: 49 U.S.C. 1344, 1354(a), 1355, 1421, 1423, 1425, 1428, 1429, and 1430; 49 U.S.C. 106(g).

GENERAL

§ 27.901 Installation.

(a) For the purpose of this part, the powerplant installation includes each part of the rotorcraft (other than the main and auxiliary rotor structures) that—

(1) Is necessary for propulsion;

(2) Affects the control of the major propulsive units; or

(3) Affects the safety of the major propulsive units between normal inspections or overhauls.

(b) For each powerplant installation—

(1) [Each component of the installation must be constructed, arranged, and installed to ensure its continued safe operation between normal inspections or overhauls for the range of temperature and altitude for which approval is requested;]

(2) Accessibility must be provided to allow any inspection and maintenance necessary for continued airworthiness;

(3) Electrical interconnections must be provided to prevent differences of potential between major components of the installation and the rest of the rotorcraft;

(4) Axial and radial expansion of turbine engines may not affect the safety of the installation; and

[(5) Design precautions must be taken to minimize the possibility of incorrect assembly of components and equipment essential to safe operation of the rotorcraft, except where operation which the incorrect assembly can be shown to be extremely improbable.]

(c) The installation must comply with—

(1) The installation instructions provided under § 33.5 of this chapter; and

(2) The applicable provisions of this subpart.

(Amdt. 27–2, Eff. 2/25/68); (Amdt. 27–12, Eff. 5/2/77); (Amdt. 27–23, Eff. 10/3/88)

§ 27.903 Engines.

(a) *Engine type certification.* [Each engine must have an approved type certificate. Reciprocating engines for use in helicopters must be qualified in accordance with § 33.49(d) of this chapter or be otherwise approved for the intended usage.]

(b) [*Engine or drive system cooling fan blade protection.*]

[(1) If an engine or rotor drive system cooling fan is installed, there must be means to protect the rotorcraft and allow a safe landing if a fan blade fails. This must be shown by showing that—

[(i) The fan blades are contained in case of failure;

[(ii) Each fan is located so that a failure will not jeopardize safety; or

[(iii) Each fan blade can withstand an ultimate load of 1.5 times the centrifugal force resulting from operation limited by the following:

[(A) For fans driven directly by the engine—

[(*1*) The terminal engine r.p.m. under uncontrolled conditions; or

[(*2*) An overspeed limiting device.

[(B) For fans driven by the rotor drive system, the maximum rotor drive system rotational speed to be expected in service, including transients.

[(2) Unless a fatigue evaluation under § 27.571 is conducted, it must be shown that cooling fan blades are not operating at resonant conditions within the operating limits of the rotorcraft.]

(c) *Turbine engine installation.* For turbine engine installations, the powerplant systems associated with engine control devices, systems, and instrumentation must be designed to give reasonable assurance that those engine operating limitations that adversely affect turbine rotor structural integrity will not be exceeded in service.

(Amdt. 27–11, Eff. 2/1/77); (Amdt. 27–20, Eff. 3/26/84); (Amdt. 27–23, Eff. 10/3/88)

(c) No part of the rotor drive system may be subjected to excessive vibration stresses.

ROTOR DRIVE SYSTEM

§ 27.917 Design.

(a) Each rotor drive system must incorporate a unit for each engine to automatically disengage that engine from the main and auxiliary rotors if that engine fails.

(b) Each rotor drive system must be arranged so that each rotor necessary for control in autorotation will continue to be driven by the main rotors after disengagement of the engine from the main and auxiliary rotors.

(c) If a torque limiting device is used in the rotor drive system, it must be located so as to allow continued control of the rotorcraft when the device is operating.

(d) The rotor drive system includes any part necessary to transmit power from the engines to the rotor hubs. This includes gear boxes, shafting, universal joints, couplings, rotor brake assemblies, clutches, supporting bearings for shafting, any attendant accessory pads or drives, and any cooling fans that are a part of, attached to, or mounted on the rotor drive system.

(Amdt. 27–11, Eff. 2/1/77)

§ 27.921 Rotor brake.

If there is a means to control the rotation of the rotor drive system independently of the engine, any limitations on the use of that means must be specified, and the control for that means must be guarded to prevent inadvertent operation.

§ 27.923 Rotor drive system and control mechanism tests.

(a) Each part tested as prescribed in this section must be in a serviceable condition at the end of the tests. No intervening disassembly which might affect test results may be conducted.

(c) A 60-hour part of the test prescribed in paragraph (b) of this section must be run at not less than maximum continuous torque and the maximum speed for use with maximum continuous torque. In this test, the main rotor controls must be set in the position that will give maximum longitudinal cyclic pitch change to simulate forward flight. The auxiliary rotor controls must be in the position for normal operation under the conditions of the test.

(d) A 30-hour or, for rotorcraft for which the use of either 30-minute OEI power or continuous OEI power is requested, a 25-hour part of the test prescribed in paragraph (b) of this section must be run at not less than 75 percent of maximum continuous torque and the minimum speed for use with 75 percent of maximum continuous torque. The main and auxiliary rotor controls must be in the position for normal operation under the conditions of the test.

(e) [A 10-hour part of the test prescribed in paragraph (b) of this section must be run at not less than takeoff torque and the maximum speed for use with takeoff torque. The main and auxiliary rotor controls must be in the normal position for vertical ascent.

[(1) For multiengine rotorcraft for which the use of 2 1/2-minute OEI power is requested, 12 runs during the 10-hour test must be conducted as follows:

[(i) Each run must consist of at least one period of 2 1/2 minutes with takeoff torque and the maximum speed for use with takeoff torque on all engines.

[(ii) Each run must consist of at least one period for each engine in sequence, during which that engine simulates a power failure and the remaining engines are run at 2 1/2-minute OEI torque and the maximum speed for use with 2 1/2-minute OEI torque for 2 1/2 minutes.

[(2) For multiengine, turbine-powered rotorcraft for which the use of 30-second and 2-minute OEI power is requested, 10 runs must be conducted as follows:

[(i) Immediately following a takeoff run of at least 5 minutes, each power source must

the test sequence must be conducted following stabilization at takeoff power.

[(ii) For the purpose of this paragraph, an affected power input includes all parts of the rotor drive system which can be adversely affected by the application of higher or asymmetric torque and speed prescribed by the test.

[(iii) This test may be conducted on a representative bench test facility when engine limitations either preclude repeated use of this power or would result in premature engine removal during the test. The loads, the vibration frequency, and the methods of application to the affected rotor drive system components must be representative of rotorcraft conditions. Test components must be those used to show compliance with the remainder of this section.]

(f) The parts of the test prescribed in paragraphs (c) and (d) of this section must be conducted in intervals of not less than 30 minutes and may be accomplished either on the ground or in flight. The part of the test prescribed in paragraph (e) of this section must be conducted in intervals of not less than 5 minutes.

(g) At intervals of not more than 5 hours during the tests prescribed in paragraphs (c) (d), and (e) of this section, the engine must be stopped rapidly enough to allow the engine and rotor drive to be automatically disengaged from the rotors.

(h) Under the operating conditions specified in paragraph (c) of this section, 500 complete cycles of lateral control, 500 complete cycles of longitudinal control of the main rotors, and 500 complete cycles of control of each auxiliary rotor must be accomplished. A ''complete cycle'' involves movement of the controls from the neutral position, through both extreme positions, and back to the neutral position, except that control movements need not produce loads or flapping motions exceeding the maximum loads or motions encountered in flight. The cycling may be accomplished during the testing prescribed in paragraph (c) of this section.

(i) At least 200 start-up clutch engagements must be accomplished—

(k) For multiengine rotorcraft for which the use of continuous OEI power is requested, five runs must be made at continuous OEI torque and the maximum speed for use with continuous OEI torque, in which each engine, in sequence, is made inoperative and the remaining engine(s) is run for a 1-hour period.

(Amdt. 27–2, Eff. 2/25/68); (Amdt. 27–12, Eff. 5/2/77); (Amdt. 27–23, Eff. 10/3/88); [(Amdt. 27–29, Eff. 10/17/94)]

§ 27.927 Additional tests.

(a) Any additional dynamic, endurance, and operational tests, and vibratory investigations necessary to determine that the rotor drive mechanism is safe, must be performed.

(b) If turbine engine torque output to the transition can exceed the highest engine or transmission torque rating limit, and that output is not directly controlled by the pilot under normal operating conditions (such as where the primary engine power control is accomplished through the flight control), the following test must be made:

(1) Under conditions associated with all engines operating, make 200 applications, for 10 seconds each, of torque that is at least equal to the lesser of—

(i) The maximum torque used in meeting § 27.923 plus 10 percent; or

(ii) The maximum attainable torque output of the engines, assuming that torque limiting devices, if, any, function properly.

(2) For multiengine rotorcraft under conditions associated with each engine, in turn, becoming inoperative, apply to the remaining transmission torque inputs the maximum torque attainable under probable operating conditions, assuming that torque limiting devices, if, any, function properly. Each transmission input must be tested at this maximum torque for at least 15 minutes.

(3) [The tests prescribed in this paragraph must be conducted on the rotorcraft at the maximum rotational speed intended for the power

tive conditions for 15 minutes after the loss of pressure in the rotor drive primary oil system.

(Amdt. 27–2, Eff. 2/25/68); (Amdt. 27–12, Eff. 5/2/77); (Amdt. 27–23, Eff. 10/3/88)

§ 27.931 Shafting critical speed.

(a) The critical speeds of any shafting must be determined by demonstration, except that analytical methods may be used if reliable methods of analysis are available for the particular design.

(b) If any critical speed lies within, or close to, the operating ranges for idling, power on, and autorotative conditions, the stresses occurring at that speed must be within safe limits. This must be shown by tests.

(c) If analytical methods are used and show that no critical speed lies within the permissible operating ranges, the margins between the calculated critical speeds and the limits of the allowable operating ranges must be adequate to allow for possible variations between the computed and actual values.

§ 27.935 Shafting joints.

Each universal joint, slip joint, and other shafting joints whose lubrication is necessary for operation must have provision for lubrication.

§ 27.939 Turbine engine operating characteristics.

(a) Turbine engine operating characteristics must be investigated in flight to determine that no adverse characteristics (such as stall, surge, or flameout) are present, to a hazardous degree, during normal and emergency operation within the range of operating limitations of the rotorcraft and the engine.

(b) The turbine engine air inlet system may not, as a result of airflow distortion during normal operation, cause vibration harmful to the engine.

(c) For governor-controlled engines, it must be shown that there exists no hazardous torsional instability of the drive system associated with criti-

(a) Each fuel system must be constructed and arranged to ensure a flow of fuel at a rate and pressure established for proper engine functioning under any likely operating condition, including the maneuvers for which certification is requested.

(b) Each fuel system must be arranged so that—

(1) No fuel pump can draw fuel from more than one tank at a time; or

(2) There are means to prevent introducing air into the system.

(c) Each fuel system for a turbine engine must be capable of sustained operation throughout its flow and pressure range with fuel initially saturated with water at 80°F and having 0.75cc of free water per gallon added and cooled to the most critical condition for icing likely to be encountered in operation.

(Amdt. 27–9, Eff. 10/31/74)

§ 27.953 Fuel system independence.

(a) Each fuel system for multiengine rotorcraft must allow fuel to be supplied to each engine through a system independent of those parts of each system supplying fuel to other engines. However, separate fuel tanks need not be provided for each engine.

(b) If a single fuel tank is used on a multiengine rotorcraft, the following must be provided:

(1) Independent tank outlets for each engine, each incorporating a shutoff valve at the tank. This shutoff valve may also serve as the firewall shutoff valve required by § 27.995 if the line between the valve and the engine compartment does not contain a hazardous amount of fuel that can drain into the engine compartment.

(2) At least two vents arranged to minimize the probability of both vents becoming obstructed simultaneously.

(3) Filler caps designed to minimize the probability of incorrect installation or inflight loss.

(4) A fuel system in which those parts of the system from each tank outlet to any engine are independent of each part of each system supplying fuel to other engines.

(Amdt. 27–23, Eff. 10/3/88)

§ 27.955 Fuel flow.

(a) *General.* The fuel system for each engine must be shown to provide the engine with at least 100 percent of the fuel required under each operating and maneuvering condition to be approved for the rotorcraft including, as applicable, the fuel required to operate the engine(s) under the test conditions required by § 27.927. Unless equivalent methods are used, compliance must be shown by test during which the following provisions are met except that combinations of conditions which are shown to be improbable need not be considered.

(1) The fuel pressure, corrected for critical accelerations, must be within the limits specified by the engine type certificate data sheet.

(2) The fuel level in the tank may not exceed that established as unusable fuel supply for the tank under § 27.959, plus the minimum additional fuel necessary to conduct the test.

(3) The fuel head between the tank outlet and the engine inlet must be critical with respect to rotorcraft flight attitudes.

(4) The critical fuel pump (for pump-fed systems) is installed to produce (by actual or simulated failure) the critical restriction to fuel flow to be expected from pump failure.

(5) Critical values of engine rotation speed, electrical power, or other sources of fuel pump motive power must be applied.

(6) Critical values of fuel properties which adversely affect fuel flow must be applied.

(7) The fuel filter required by § 27.997 must be blocked to the degree necessary to simulate the accumulation of fuel contamination required to activate the indicator required by § 27.1305(q).

(b) *Fuel transfer systems.* If normal operation of the fuel system requires fuel to be transferred to an engine feed tank, the transfer must occur automatically via a system which has been shown to maintain the fuel level in the engine feed tank within acceptable limits during flight or surface operation of the rotorcraft.

(Amdt. 27–1, Eff. 6/4/67); (Amdt. 27–23, Eff. 10/3/88)

§ 27.959 Unusable fuel supply.

The unusable fuel supply for each tank must be established as not less than the quantity at which the first evidence of malfunction occurs under the most adverse fuel feed condition occurring under any intended operations and flight maneuvers involving that tank.

§ 27.961 Fuel system hot weather operation.

Each suction lift fuel system and other fuel systems with features conducive to vapor formation must be shown by test to operate satisfactorily (within certification limits) when using fuel at a temperature of 110° F under critical operating conditions including, if applicable, the engine operating conditions defined by § 27.927(b)(1) and (b)(2).

(Amdt. 27–23, Eff. 10/3/88)

§ 27.963 Fuel tanks: General.

(a) Each fuel tank must be able to withstand, without failure, the vibration, inertia, fluid, and structural loads to which it may be subjected in operation.

(b) Each fuel tank of 10 gallons or greater capacity must have internal baffles, or must have external support to resist surging.

(c) Each fuel tank must be separated from the engine compartment by a firewall. At least one-half inch of clear airspace must be provided between the tank and the firewall.

(d) Spaces adjacent to the surfaces of fuel tanks must be ventilated so that fumes cannot accumulate in the tank compartment in case of leakage. If two or more tanks have interconnected outlets, they must be considered as one tank, and the airspaces in those tanks must be interconnected to prevent the flow of fuel from one tank to another as a result of a difference in pressure between those airspaces.

ments must be isolated by fume-proof and fuel-proof enclosures that are drained and vented to the exterior of the rotorcraft. The design and construction of the enclosure must provide necessary protection for the tank and be adequate to withstand loads and abrassions to be expected in personnel compartments.

(Amdt. 27–23, Eff. 10/3/88)

§ 27.965 Fuel tank tests.

(a) Each fuel tank must be able to withstand the applicable pressure tests in this section without failure or leakage. If practicable, test pressures may be applied in a manner simulating the pressure distribution in service.

(b) Each conventional metal tank, nonmetallic tank with walls that are not supported by the rotorcraft structure, and integral tank must be subjected to a pressure of 3.5 p.s.i. unless the pressure developed during maximum limit acceleration or emergency deceleration with a full tank exceeds this value, in which case a hydrostatic head, or equivalent test, must be applied to duplicate the acceleration loads as far as possible. However, the pressure need not exceed 3.5 p.s.i. on surfaces not exposed to the acceleration loading.

(c) Each nonmetallic tank with walls supported by the rotorcraft structure must be subjected to the following tests:

(1) A pressure test of at least 2.0 p.s.i. This test may be conducted on the tank alone in conjunction with the test specified in paragraph (c)(2) of this section.

(2) A pressure test, with the tank mounted in the rotorcraft structure, equal to the load developed by the reaction of the contents, with the tank full, during maximum limit acceleration or emergency deceleration. However, the pressure need not exceed 2.0 p.s.i. on surfaces not exposed to the acceleration loading.

(d) Each tank with large unsupported or unstiffened flat areas, or with other features whose failure or deformation could cause leakage, must be subjected to the following test or its equivalent:

(i) If no frequency of vibration resulting from any r.p.m. within the normal operating range of engine or rotor system speeds is critical, the test frequency of vibration, in number of cycles per minute must, unless a frequency based on a more rational calculation is used, be the number obtained by averaging the maximum and minimum power-on engine speeds (r.p.m.) for reciprocating engine powered rotorcraft or 2,000 c.p.m. for turbine engine powered rotorcraft.

(ii) If only one frequency of vibration resulting from any r.p.m. within the normal operating range of engine or rotor system speeds is critical, that frequency of vibration must be the test frequency.

(iii) If more than one frequency of vibration resulting from any r.p.m. within the normal operating range of engine or rotor system speeds is critical, the most critical of these frequencies must be the test frequency.

(4) Under paragraphs (d)(3)(ii) and (iii) of this section, the time of test must be adjusted to accomplish the same number of vibration cycles as would be accomplished in 25 hours at the frequency specified in paragraph (d)(3)(i) of this section.

(5) During the test, the tank assembly must be rocked at the rate of 16 to 20 complete cycles per minute through an angle of 15 degrees on both sides of the horizontal (30 degrees total), about the most critical axis, for 25 hours). If motion about more than one axis is likely to be critical, the tank must be rocked about each critical axis for 12½ hours.

(Amdt. 27–12, Eff. 5/2/77)

§ 27.969 Fuel tank expansion space.

Each fuel tank or each group of fuel tanks with interconnected vent systems must have an expansion space of not less than 2 percent of the tank capacity). It must be impossible to fill the fuel tank

is greater, unless—

(1) The fuel system has a sediment bowl or chamber that is accessible for preflight drainage and has a minimum capacity of 1 ounce for every 20 gallons of fuel tank capacity; and

(2) Each fuel tank drain is located so that in any ground attitude to be expected in service, water will drain from all parts of the tank to the sediment bowl or chamber.

(b) Each sump, sediment bowl, and sediment chamber drain required by the section must comply with the drain provisions of § 27.999(b).

(Amdt. 27–23, Eff. 10/3/88)

§ 27.973 Fuel tank filler connection.

Each fuel tank filler connection must prevent the entrance of fuel into any part of the rotorcraft other than the tank.

§ 27.975 Fuel tank vents.

(a) Each fuel tank must be vented from the top part of the expansion space so that venting is effective under all normal flight conditions. Each vent must minimize the probability of stoppage by dirt or ice.

(b) The venting system must be designed to minimize spillage of fuel through the vents to an ignition source in the event of a rollover during landing or ground operation unless such an event is extremely remote.

(Amdt. 27–23, Eff. 10/3/88)

§ 27.977 Fuel tank outlet.

(a) There must be a fuel strainer for the fuel tank outlet or for the booster pump. This strainer must—

(1) For reciprocating engine powered rotorcraft, have 8 to 16 meshes per inch; and

(2) For turbine engine powered rotorcraft, prevent the passage of any object that could restrict fuel flow or damage any fuel system component.

FUEL SYSTEM COMPONENTS

§ 27.991 Fuel pumps.

Compliance with § 27.955 may not be jeopardized by failure of—

(a) Any one pump except pumps that are approved and installed as parts of a type certificated engine; or

(b) Any component required for pump operation except, for engine driven pumps, the engine served by that pump.

(Amdt. 27–2, Eff. 2/25/68); (Amdt. 27–23, Eff. 10/3/88)

§ 27.993 Fuel system lines and fittings.

(a) Each fuel line must be installed and supported to prevent excessive vibration and to withstand loads due to fuel pressure and accelerated flight conditions.

(b) Each fuel line connected to components of the rotorcraft between which relative motion could exist must have provisions for flexibility.

(c) Flexible hose must be approved.

(d) Each flexible connection in fuel lines that may be under pressure or subjected to axial loading must use flexible hose assemblies.

(e) No flexible hose that might be adversely affected by high temperatures may be used where excessive temperatures will exist during operation or after engine shutdown.

(Amdt. 27–2, Eff. 2/25/68)

§ 27.995 Fuel valves.

(a) There must be a positive, quick-acting valve to shut off fuel to each engine individually.

(b) The control for this valve must be within easy reach of appropriate crewmembers.

(c) Where there is more than one source of fuel supply there must be means for independent feeding from each source.

(d) No shutoff valve may be on the engine side of any firewall.

must incorporate a screen or element which is easily removable;

(b) Have a sediment trap and drain except that it need not have a drain if the strainer or filter is easily removable for drain purposes;

(c) Be mounted so that its weight is not supported by the connecting lines or by the inlet or outlet connections of the strainer or filter itself, unless adequate strength margins under all loading conditions are provided in the lines and connections; and

(d) Provide a means to remove from the fuel any contaminant which would jeopardize the flow of fuel through rotorcraft or engine fuel system components required for proper rotorcraft fuel system or engine fuel system operation.

(Amdt. 27–9, Eff. 10/31/74); (Amdt. 27–20, Eff. 3/26/84); (Amdt. 27–23, Eff. 10/3/88)

§ 27.999 Fuel system drains.

(a) There must be at least one accessible drain at the lowest point in each fuel system to completely drain the system with the rotorcraft in any ground attitude to be expected in service.

(b) Each drain required by paragraph (a) of this section must—

(1) Discharge clear of all parts of the rotorcraft;

(2) Have manual or automatic means to assure positive closure in the off position; and

(3) Have a drain valve—

(i) That is readily accessible and which can be easily opened and closed; and

(ii) That is either located or protected to prevent fuel spillage in the event of a landing with landing gear retracted.

(Amdt. 27–11, Eff. 2/1/77); (Amdt. 27–23, Eff. 10/3/88)

the rotorcraft under critical operating conditions and the maximum oil consumption of the engine under the same conditions, plus a suitable margin to ensure adequate circulation and cooling. Instead of a rational analysis of endurance and consumption, a usable oil capacity of 1 gallon for each 40 gallons of usable fuel may be used.

(c) The oil cooling provisions for each engine must be able to maintain the oil inlet temperature to that engine at or below the maximum established value. This must be shown by flight tests.

(Amdt. 27–23, Eff. 10/3/88)

§ 27.1013 Oil tanks.

Each oil tank must be designed and installed so that—

(a) It can withstand, without failure, each vibration, inertia, fluid, and structural load expected in operation;

(b) [Reserved]

(c) Where used with a reciprocating engine, it has an expansion space of not less than the greater of 10 percent of the tank capacity or 0.5 gallon, and where used with a turbine engine, it has an expansion space of not less than 10 percent of the tank capacity.

(d) It is impossible to fill the tank expansion space inadvertently with the rotorcraft in the normal ground attitude;

(e) Adequate venting is provided; and

(f) There are means in the filler opening to prevent oil overflow from entering the oil tank compartment.

(Amdt. 27–9, Eff. 10/31/74)

§ 27.1015 Oil tank tests.

Each oil tank must be designed and installed so that it can withstand, without leakage, an internal pressure of 5 p.s.i., except that each pressurized oil tank used with a turbine engine must be designed and installed so that it can withstand,

exist must have provisions for flexibility.

(c) Flexible hose must be approved.

(d) Each oil line must have an inside diameter of not less than the inside diameter of the engine inlet or outlet. No line may have splices between connections.

§ 27.1019 Oil strainer or filter.

(a) Each turbine engine installation must incorporate an oil strainer or filter through which all of the engine oil flows and which meets the following requirements:

(1) Each oil strainer or filter that has a bypass must be constructed and installed so that oil will flow at the normal rate through the rest of the system with the strainer or filter completely blocked.

(2) The oil strainer or filter must have the capacity (with respect to operating limitations established for the engine) to ensure that engine oil system functioning is not impaired when the oil is contaminated to a degree (with respect to particle size and density) that is greater than that established for the engine under part 33 of this chapter.

(3) The oil strainer or filter, unless it is installed at an oil tank outlet, must incorporate a means to indicate contamination before it reaches the capacity established in accordance with paragraph (a)(2) of this section.

(4) The bypass of a strainer or filter must be constructed and installed so that the release of collected contaminants is minimized by appropriate location of the bypass to ensure that collected contaminants are not in the bypass flow path.

(5) An oil strainer or filter that has no bypass, except one that is installed at an oil tank outlet, must have a means to connect it to the warning system required in § 27.1305(r).

(b) Each oil strainer or filter in a powerplant installation using reciprocating engines must be constructed and installed so that oil will flow at the

(b) Have manual or automatic means for positive locking in the closed position.

(Amdt. 27–20, Eff. 3/26/84)

[§ 27.1027 Transmissions and gearboxes: General.]

[(a) Pressure lubrication systems for transmissions and gearboxes must comply with the engine oil system requirements of §§ 27.1013 (except paragraph (c)), 27.1015, 27.1017, 27.1021, and 27.1337(d).

[(b) Each pressure lubrication system must have an oil strainer or filter through which all of the lubricant flows and must—

[(1) Be designed to remove from the lubricant any contaminant which may damage transmission and drive system components or impede the flow of lubricant to a hazardous degree;

[(2) Be equipped with a means to indicate collection of contaminants on the filter or strainer at or before opening of the bypass required by paragraph (b)(3) of this section; and

[(3) Be equipped with a bypass constructed and installed so that—

[(i) The lubricant will flow at the normal rate through the rest of the system with the strainer of filter completely blocked; and

[(ii) The release of collected contaminants is minimized by appropriate location of the bypass to ensure that collected contaminants are not in the bypass flowpath.

[(c) For each lubricant tank or sump outlet supplying lubrication to rotor drive systems and rotor drive system components, a screen must be provided to prevent entrance into the lubrication system of any object that might obstruct the flow of lubricant from the outlet to the filter required by paragraph (b) of this section. The requirements of paragraph (b) do not apply to screens installed at lubricant tank of sump outlets.

to maintain the temperatures of powerplant components within the limits established for these components under critical surface (ground or water) and flight operating conditions for which certification is required and after normal shutdown. Powerplant components to be considered include but may not be limited to engines, rotor drive system components, auxiliary power units, and the cooling or lubricating fluids used with these components.

(b) Compliance with paragraph (a) of this section must be shown in tests conducted under the conditions prescribed in that paragraph.

(Amdt. 27–2, Eff. 2/25/68); (Amdt. 27–23, Eff. 10/3/88)

§ 27.1043 Cooling tests.

(a) *General.* For the tests prescribed in § 27.1041(b), the following apply:

(1) If the tests are conducted under conditions deviating from the maximum ambient atmospheric temperature specified in paragraph (b) of this section, the recorded powerplant temperatures must be corrected under paragraphs (c) and (d) of this section unless a more rational correction method is applicable.

(2) No corrected temperature determined under paragraph (a)(1) of this section may exceed established limits.

(3) For reciprocating engines, the fuel used during the cooling tests must be of the minimum grade approved for the engines, and the mixture settings must be those normally used in the flight stages for which the cooling tests are conducted.

(4) The test procedures must be as prescribed in § 27.1045.

(b) *Maximum ambient atmospheric temperature.* A maximum ambient atmospheric temperature corresponding to sea level conditions of at least 100 degrees F must be established. The assumed temperature lapse rate is 3.6 degrees F per thousand feet of altitude above sea level until a temperature of −69.7 degrees F is reached, above which altitude the temperature is considered constant at −69.7 degrees F. However, for winterization

ture of the ambient air at the time of the first occurrence of the maximum component or fluid temperature recorded during the cooling test.

(d) *Correction factor for cylinder barrel temperatures.* Cylinder barrel temperatures must be corrected by adding to them 0.7 times the difference between the maximum ambient atmospheric temperature and the temperature of the ambient air at the time of the first occurrence of the maximum cylinder barrel temperature recorded during the cooling test.

(Amdt. 27–11, Eff. 2/1/77); (Amdt. 27–14, Eff. 3/1/78)

§ 27.1045 Cooling test procedures.

(a) *General.* For each stage of flight, the cooling tests must be conducted with the rotorcraft

(1) In the configuration most critical for cooling; and

(2) Under the conditions most critical for cooling.

(b) *Temperature stabilization.* For the purpose of the cooling tests, a temperature is "stabilized" when its rate of change is less than 20° F. per minute. The following component and engine fluid temperature stabilization rules apply:

(1) For each rotorcraft, and for each stage of flight—

(i) The temperatures must be stabilized under the conditions from which entry is made into the stage of flight being investigated; or

(ii) if the entry condition normally does not allow temperatures to stabilize, operation through the fuel entry condition must be conducted before entry into the stage of flight being investigated in order to allow the temperatures to attain their natural levels at the time of entry.

(2) For each helicopter during the takeoff stage of flight, the climb at takeoff power must be preceded by a period of hover during which the temperatures are stabilized.

(c) *Duration of test.* For each stage of flight the tests must be continued until—

§ 27.1091 Air induction.

(a) The air induction system for each engine must supply the air required by that engine under the operating conditions and maneuvers for which certification is requested.

(b) Each cold air induction system opening must be outside the cowling if backfire flames can emerge.

(c) If fuel can accumulate in any air induction system, that system must have drains that discharge fuel—

(1) Clear of the rotorcraft; and

(2) Out of the path of exhaust flames.

[(d)] For turbine engine powered rotorcraft—

(1)There must be means to prevent hazardous quantities of fuel leakage or overflow from drain, vents, or other components of flammable fluid systems from entering the engine intake system; and

(2) The air inlet ducts must be located or protected so as to minimize the ingestion of foreign matter during takeoff, landing, and taxiing.

(Amdt. 27–2, Eff. 2/25/68); (Amdt. 27–23, Eff. 10/3/88)

§ 27.1093 Induction system icing protection.

(a) *Reciprocating engines.* Each reciprocating engine air induction system must have means to prevent and eliminate icing. Unless this is done by other means, it must be shown that, in air free of visible moisture at a temperature of 300 F., and with the engines at 75 percent of maximum continuous power—

(1) Each rotorcraft with sea level engines using conventional venturi carburetors has a preheater that can provide a heat rise of 90° F.;

(2) Each rotorcraft with sea level engines using carburetors tending to prevent icing has a sheltered alternate source of air, and that the preheat supplied to the alternate air intake is not less than the rise determined in accordance with paragraph (a)(1) of this section; and

(3) Each rotorcraft with sea level engines using fuel injection systems has a source of heated air for the induction system that can provide a heat rise sufficient to prevent icing.

(b) *Turbine engines.*

(1) [It must be shown that each turbine engine and its air inlet system can operate throughout the flight power range of the engine (including idling)—

[(i) Without accumulating ice on engine or inlet system components that would adversely affect engine operation or cause a serious loss of power under the icing conditions specified in appendix C of part 29 of this chapter; and

[(ii) In snow, both falling and blowing, without adverse effect on engine operation, within the limitations established for the rotorcraft.]

(2) Each turbine engine must idle for 30 minutes on the ground, with the air bleed available for engine icing protection at its critical condition, without adverse effect, in an atmosphere that is at a temperature between 15° and 30° F (between −9° and −1° C) and has a liquid water content not less than 0.3 grams per cubic meter in the form of drops having a mean effective diameter of not less than 20 microns, followed by momentary operation at takeoff power or thrust. During the 30 minutes of idle operation, the engine may be run up periodically to a moderate power or thrust setting in a manner acceptable to the Administrator.

(c) *Supercharged reciprocating engines.* For each engine having superchargers to pressurize the air before it enters the carburetor, the heat rise in the air caused by that supercharging at any altitude may be utilized in determining compliance with paragraph (a) of this section if the heat rise utilized is that which will be available, automatically, for the applicable altitude and operating condition because of supercharging.

(Amdt. 27–9, Eff. 10/31/74); (Amdt. 27–11, Eff. 2/1/77); (Amdt. 27–12, Eff. 5/2/77); (Amdt. 27–20, Eff. 3/26/84); (Amdt. 27–23, Eff. 10/3/88)

engine air intake, fuel system components, and drains;

(d) Each exhaust system part with a surface hot enough to ignite flammable fluids or vapors must be located or shielded so that leakage from any system carrying flammable fluids or vapors will not result in a fire caused by impingement of the fluids or vapors on any part of the exhaust system including shields for the exhaust system.

(e) Exhaust gases may not impair pilot vision at night due to glare; and

(f) If significant traps exist, each turbine engine exhaust system must have drains discharging clear of the rotorcraft, in any normal ground and flight attitudes, to prevent fuel accumulation after the failure of an attempted engine start.

(g) Each exhaust heat exchanger must incorporate means to prevent blockage of the exhaust port after any internal heat exchanger failure.

(Amdt. 27–12, Eff. 5/2/77)

§ 27.1123 Exhaust piping.

(a) Exhaust piping must be heat and corrosion resistant, and must have provisions to prevent failure due to expansion by operating temperatures.

(b) Exhaust piping must be supported to withstand any vibration and inertia loads to which it would be subjected in operations.

(c) Exhaust piping connected to components between which relative motion could exist must have provisions for flexibility.

(Amdt. 27–11, Eff. 2/1/77)

POWERPLANT CONTROLS AND ACCESSORIES

§ 27.1141 Powerplant controls: General.

(a) Powerplant controls must be located and arranged under § 27.777 and marked under § 27.1555.

(b) Each flexible powerplant control must be approved.

(ii) is moving between the fully open and fully closed position.

(d) For turbine engine powered rotorcraft, no single failure or malfunction, or probable combination thereof, in any powerplant control system may cause the failure of any powerplant function necessary for safety.

(Amdt. 27–12, Eff. 5/2/77); (Amdt. 27–23, Eff. 10/3/88)

§ 27.1143 Engine controls.

(a) There must be a separate power control for each engine.

(b) Power controls must be grouped and arranged to allow—

(1) Separate control of each engine; and

(2) Simultaneous control of all engines.

(c) Each power control must provide a positive and immediately responsive means of controlling its engine.

(d) If a power control incorporates a fuel shutoff feature, the control must have a means to prevent the inadvertent movement of the control into the shutoff position. The means must—

(1) Have a positive lock or stop at the idle position; and

(2) Require a separate and distinct operation to place the control in the shutoff position.

[(e) For rotorcraft to be certificated for a 30-second OEI power rating, a means must be provided to automatically activate and control the 30-second OEI power and prevent any engine from exceeding the installed engine limits associated with the 30-second OEI power rating approved for the rotorcraft.]

(Amdt. 27–11, Eff. 2/1/77); (Amdt. 27–23, Eff. 10/3/88); [(Amdt. 27–29, Eff. 10/17/94)]

§ 27.1145 Ignition switches.

(a) There must be a means to quickly shut off all ignition by the grouping of switches or by a master ignition control.

have a separate control and the controls must be arranged to allow—

(a) Separate control of each engine; and

(b)Simultaneous control of all engines.

§ 27.1163 Powerplant accessories.

(a) Each engine-mounted accessory must—

(1) Be approved for mounting on the engine involved;

(2) Use the provisions on the engine for mounting; and

(3) Be sealed in such a way as to prevent contamination of the engine oil system and the accessory system.

(b) Unless other means are provided, torque limiting means must be provided for accessory drives located on any component of the transmission and rotor drive system to prevent damage to these components from excessive accessory load.

(Amdt. 27–2, Eff. 2/25/68); (Amdt. 27–20, Eff. 3/26/84); (Amdt. 27–23, Eff. 10/3/88)

POWERPLANT FIRE PROTECTION

§ 27.1183 Lines, fittings, and components.

(a) Except as provided in paragraph (b) of this section, each line, fitting, and other component carrying flammable fluid in any area subject to engine fire conditions must be fire resistant, except that flammable fluid tanks and supports which are part of and attached to the engine must be fireproof or be enclosed by a fireproof shield unless damage by fire to any non-fireproof part will not cause leakage or spillage of flammable fluid. Components must be shielded or located so as to safeguard against the ignition of leaking flammable fluid. An integral oil sump of less than 25-quart capacity on a reciprocating engine need not be fireproof nor be enclosed by a fireproof shield.

(b) Paragraph (a) does not apply to—

(1) Lines, fittings, and components which are already approved as part of a type certificated engine; and

(a) Each fuel tank must be isolated from the engines by a firewall or shroud.

(b) Each tank or reservoir, other than a fuel tank, that is part of a system containing flammable fluids or gases must be isolated from the engine by a firewall or shroud, unless the design of the system, the materials used in the tank and its supports, the shutoff means, and the connections, lines and controls provide a degree of safety equal to that which would exist if the tank or reservoir were isolated from the engines.

(c) There must be at least one-half inch of clear airspace between each tank and each firewall or shroud isolating that tank, unless equivalent means are used to prevent heat transfer from each engine compartment to the flammable fluid.

(Amdt. 27–2, Eff. 2/25/68); (Amdt. 27–11, Eff. 2/1/77)

§ 27.1187 Ventilation.

Each compartment containing any part of the powerplant installation must have provision for ventilation.

§ 27.1189 Shutoff means.

(a) There must be means to shut off each line carrying flammable fluids into the engine compartment, except—

(1) Lines, fittings, and components forming an integral part of an engine;

(2) For oil systems for which all components of the system, including oil tanks, are fireproof or located in areas not subject to engine fire conditions; and

(3) For reciprocating engine installations only, engine oil system lines in installations using engines of less than 500 cu. in. displacement.

(b) There must be means to guard against inadvertent operation of each shutoff, and to make it possible for the crew to reopen it in flight after it has been closed.

(c) Each shutoff valve and its control must be designed, located, and protected to function properly

from personnel compartments, structures, controls, rotor mechanisms, and other parts that are—

(1) Essential to a controlled landing; and

(2) Not protected under § 27.861.

(b) Each auxiliary power unit and combustion heater, and any other combustion equipment to be used in flight, must be isolated from the rest of the rotorcraft by firewalls, shrouds, or equivalent means.

(c) In meeting paragraphs (a) and (b) of this section, account must be taken of the probable path of a fire as affected by the airflow in normal flight and in autorotation.

(d) Each firewall and shroud must be constructed so that no hazardous quantity of air, fluids, or flame can pass from any engine compartment to other parts of the rotorcraft.

(e) Each opening in the firewall or shroud must be sealed with close-fitting, fireproof grommets, bushings, or firewall fittings.

(f) Each firewall and shroud must be fireproof and protected against corrosion.

(Amdt. 27–2, Eff. 2/25/68)

§ 27.1193 Cowling and engine compartment covering.

(a) Each cowling and engine compartment covering must be constructed and supported so that it

ing must be at least fire resistant.

(e) Each part of the cowling or engine compartment covering subject to high temperatures due to its nearness to exhaust system parts or exhaust gas impingement must be fireproof.

(f) A means of retaining each openable or readily removable panel, cowling, or engine or rotor drive system covering must be provided to preclude hazardous damage to rotors or critical control components in the event of structural or mechanical failure of the normal retention means, unless such failure is extremely improbable.

(Amdt. 27–23, Eff. 10/3/88)

§ 27.1194 Other surfaces.

All surfaces aft of, and near, powerplant compartments, other than tail surfaces not subject to heat, flames, or sparks emanating from a powerplant compartment, must be at least fire resistant.

(Amdt. 27–2, Eff. 2/25/68)

§ 27.1195 Fire detector systems.

Each turbine engine powered rotorcraft must have approved quick-acting fire detectors in numbers and locations insuring prompt detection of fire in the engine compartment which cannot be readily observed in flight by the pilot in the cockpit.

(Amdt. 27–5, Eff. 4/23/71)

GENERAL

§ 27.1301 Function and installation.

Each item of installed equipment must—

(a) Be of a kind and design appropriate to its intended function;

(b) Be labeled as to its identification, function, or operating limitations, or any applicable combination of these factors;

(c) Be installed according to limitations specified for that equipment; and

(d) Function properly when installed.

§ 27.1303 Flight and navigation instruments.

The following are the required flight and navigation instruments:

(a) An airspeed indicator.

(b) An altimeter.

(c) A magnetic direction indicator.

§ 27.1305 Powerplant instruments.

The following are the required powerplant instruments:

(a) A carburetor air temperature indicator, for each engine having preheater that can provide a heat rise in excess of 60° F.

(b) A cylinder head temperature indicator, for each—

(1) Air cooled engine;

(2) Rotorcraft with cooling shutters; and

(3) Rotorcraft for which compliance with § 27.1043 is shown in any condition other than the most critical flight condition with respect to cooling.

(c) A fuel pressure indicator, for each pump-fed engine.

(d) A fuel quantity indicator, for each fuel tank.

(e) A manifold pressure indicator, for each altitude engine.

(f) An oil temperature warning device to indicate when the temperature exceeds a safe value in each main rotor drive gearbox (including any gearboxes essential to rotor phasing) having an oil system independent of the engine oil system.

(g) An oil pressure warning device to indicate when the pressure falls below a safe value in each pressure-lubricated main rotor drive gearbox (including any gearboxes essential to rotor phasing) having an oil system independent of the engine oil system.

(h) An oil pressure indicator for each engine.

(i) An oil quantity indicator for each oil tank.

(j) An oil temperature indicator for each engine.

(k) At least one tachometer to indicate the r.p.m. of each engine and, as applicable—

(1) The r.p.m. of the single main rotor;

(2) The common r.p.m. of any main rotors whose speeds cannot vary appreciably with respect to each other; or

(3) The r.p.m. of each main rotor whose speed can vary appreciably with respect to that of another main rotor.

(l) A low fuel warning device for each fuel tank which feeds an engine. This device must—

(1) Provide a warning to the flightcrew when approximately 10 minutes of usable fuel remains in the tank; and

(2) Be independent of the normal fuel quantity indicating system.

(m) Means to indicate to the flightcrew the failure of any fuel pump installed to show compliance with § 27.955.

(n) A gas temperature indicator for each turbine engine.

(o) Means to enable the pilot to determine the torque of each turboshaft engine, if a torque limitation is established for that engine under § 27.1521(e).

(p) For each turbine engine, an indicator to indicate the functioning of the powerplant ice protection system.

(q) An indicator for the fuel filter required by § 27.997 to indicate the occurence of contamination of the filter at the degree established by the applicant in compliance with § 27.955.

(r) For each turbine engine, a warning means for the oil strainer or filter required by § 27.1019, if it has no bypass, to warn the pilot of the occurrence of contamination of the strainer or filter

levels, when the event begins, and when the time interval expires.

[(u) For each turbine engine utilizing 30-second/2-minute OEI power, a device or system must be provided for use by ground personnel which—

[(1) Automatically records each usage and duration of power at the 30-second and 2-minute OEI levels;

[(2) Permits retrieval of the recorded data;

[(3) Can be reset only by ground maintenance personnel; and

[(4) Has a means to verify proper operation of the system or device.]

(Amdt. 27–9, Eff. 10/31/74); (Amdt. 27–23, Eff. 10/3/88); [(Amdt. 27–29, Eff. 10/17/94)]

§ 27.1307 Miscellaneous equipment.

The following is the required miscellaneous equipment:

(a) An approved seat for each occupant.

(b) An approved safety belt for each occupant.

(c) A master switch arrangement.

(d) An adequate source of electrical energy, where electrical energy is necessary for operation of the rotorcraft.

(e) Electrical protective devices.

§ 27.1309 Equipment, systems, and installations.

(a) The equipment, systems, and installations whose functioning is required by this subchapter must be designed and installed to ensure that they perform their intended functions under any foreseeable operating condition.

(b) The equipment, systems, and installations of a multiengine rotorcraft must be designed to prevent hazards to the rotorcraft in the event of a probable malfunction or failure.

(c) The equipment, systems, and installations of single-engine rotorcraft must be designed to minimize hazards to the rotorcraft in the event of a probable malfunction or failure.

§ 27.1321 Arrangement and visibility.

(a) Each flight, navigation, and powerplant instrument for use by any pilot must be easily visible to him.

(b) For each multiengine rotorcraft, identical powerplant instruments must be located so as to prevent confusion as to which engine each instrument relates.

(c) Instrument panel vibration may not damage, or impair the readability or accuracy of, any instrument.

(d) If a visual indicator is provided to indicate malfunction of an instrument, it must be effective under all probable cockpit lighting conditions.

(Amdt. 27–13, Eff. 9/1/77)

§ 27.1322 Warning, caution, and advisory lights.

If warning, caution or advisory lights are installed in the cockpit, they must, unless otherwise approved by the Administrator, be—

(a) Red, for warning lights (lights indicating a hazard which may require immediate corrective action);

(b) Amber, for caution lights (lights indicating the possible need for future corrective action);

(c) Green, for safe operation lights; and

(d) Any other color, including white, for lights not described in paragraphs (a) through (c) of this section, provided the colors differs sufficiently from the colors prescribed in paragraphs (a) through (c) of this section to avoid possible confusion.

(Amdt. 27–2, Eff. 2/25/68); (Amdt. 27–11, Eff. 2/1/77)

§ 27.1323 Airspeed indicating system.

(a) Each airspeed indicating instrument must be calibrated to indicate true airspeed (at sea level with a standard atmosphere) with a minimum practicable instrument calibration error when the corresponding pitot and static pressures are applied.

(b) The airspeed indicating system must be calibrated in flight at forward speeds of 20 knots and over.

§ 27.1325 Static pressure systems.

(a) Each instrument with static air case connections must be vented so that the influence of rotorcraft speed, the opening and closing of windows, airflow variation, and moisture or other foreign matter does not seriously affect its accuracy.

(b) Each static pressure port must be designed and located in such manner that the correlation between air pressure in the static pressure system and true ambient atmospheric static pressure is not altered when the rotorcraft encounters icing conditions. An anti-icing means or an alternate source of static pressure may be used in showing compliance with this requirement. If the reading of the altimeter, when on the alternate static pressure system, differs from the reading of the altimeter when on the primary static system by more than 50 feet, a correction card must be provided for the alternate static system.

(c) Except as provided in paragraph (d) of this section, if the static pressure system incorporates both a primary and an alternate static pressure source, the means for selecting one or the other source must be designed so that—

(1) When either source is selected, the other is blocked off; and

(2) Both sources cannot be blocked off simultaneously.

(d) For unpressurized rotorcraft, paragraph (c)(1) of this section does not apply if it can be demonstrated that the static pressure system calibration, when either static pressure source is selected, is not changed by the other static pressure source being open or blocked.

(Amdt. 27–13, Eff. 9/1/77)

§ 27.1327 Magnetic direction indicator.

(a) Except as provided in paragraph (b) of this section—

(1) Each magnetic direction indicator must be installed so that its accuracy is not excessively affected by the rotorcraft's vibration or magnetic fields; and

on any heading, or a gyroscopic direction indicator, is installed. Deviations of a magnetic nonstabilized direction indicator of more than 10 degrees must be placarded in accordance with § 27.1547(e).

(Amdt. 27–13, Eff. 9/1/77)

§ 27.1329 Automatic pilot system.

(a) Each automatic pilot system must be designed so that the automatic pilot can—

(1) Be sufficiently overpowered by one pilot to allow control of the rotorcraft; and

(2) Be readily and positively disengaged by each pilot to prevent it from interfering with control of the rotorcraft.

(b) Unless there is automatic synchronization, each system must have a means to readily indicate to the pilot the alignment of the actuating device in relation to the control system it operates.

(c) Each manually operated control for the system's operation must be readily accessible to the pilots.

(d) The system must be designed and adjusted so that, within the range of adjustment available to the pilot, it cannot produce hazardous loads on the rotorcraft or create hazardous deviations in the flight path under any flight condition appropriate to its use, either during normal operation or in the event of a malfunction, assuming that corrective action begins within a reasonable period of time.

(e) If the automatic pilot integrates signals from auxiliary controls or furnishes signals for operation of other equipment, there must be positive interlocks and sequencing of engagement to prevent improper operation.

(Amdt. 27–21, Eff. 12/6/84)

§ 27.1335 Flight director systems.

If a flight director system is installed, means must be provided to indicate to the flight crew its current mode of operation. Selector switch position is not acceptable as a means of indication.

(Amdt. 27–13, Eff. 9/1/77)

the escape of excessive fluid if the line fails; and

(ii) Be installed and located so that the escape of fluids would not create a hazard.

(3) Each powerplant instrument that utilizes flammable fluids must be installed and located so that the escape of fluid would not create a hazard.

(b) *Fuel quantity indicator.* Each fuel quantity indicator must be installed to clearly indicate to the flight crew the quantity of fuel in each tank in flight. In addition—

(1) Each fuel quantity indicator must be calibrated to read "zero" during level flight when the quantity of fuel remaining in the tank is equal to the unusable fuel supply determined under § 27.959;

(2) When two or more tanks are closely interconnected by a gravity feed system and vented, and when it is impossible to feed from each tank separately, at least one fuel quantity indicator must be installed; and

(3) Each exposed sight gauge used as a fuel quantity indicator must be protected against damage.

(c) *Fuel flowmeter system.* If a fuel flowmeter system is installed, each metering component must have a means for bypassing the fuel supply if malfunction of that component severely restricts fuel flow.

(d) *Oil quantity indicator.* There must be means to indicate the quantity of oil in each tank—

(1) On the ground (including during the filling of each tank); and

(2) In flight, if there is an oil transfer system or reserve oil supply system.

(e) Rotor drive system transmissions and gearboxes utilizing ferromagnetic materials must be equipped with chip detectors designed to indicate or reveal the presence of ferromagnetic particles resulting from damage or excessive wear. Chip detectors must—

(1) Incorporate means to indicate the accumulation of ferromagnetic particles on the magnetic poles; or

ELECTRICAL SYSTEMS AND EQUIPMENT

§ 27.1351 General.

(a) *Electrical system capacity.* Electrical equipment must be adequate for its intended use. In addition—

(1) Electric power sources, their transmission cables, and their associated control and protective devices must be able to furnish the required power at the proper voltage to each load circuit essential for safe operation; and

(2) Compliance with paragraph (a)(1) of this section must be shown by an electrical load analysis, or by electrical measurements that take into account the electrical loads applied to the electrical system, in probable combinations and for probable durations.

(b) *Function.* For each electrical system, the following apply:

(1) Each system, when installed, must be—

(i) Free from hazards in itself, in its method of operation, and in its effects on other parts of the rotorcraft; and

(ii) Protected from fuel, oil, water, other detrimental substances, and mechanical damage.

(2) Electric power sources must function properly when connected in combination or independently.

(3) No failure or malfunction of any source may impair the ability of any remaining source to supply load circuits essential for safe operation.

(4) Each electric power source control must allow the independent operation of each source.

(c) *Generating system.* There must be at least one generator if the system supplies power to load circuits essential for safe operation. In addition—

(1) Each generator must be able to deliver its continuous rated power;

(2) Generator voltage control equipment must be able to dependably regulate each generator output within rated limits;

(3) Each generator must have a reverse current cutout designed to disconnect the generator from

(d) *Instruments.* There must be means to indicate to appropriate crewmembers the electric power system quantities essential for safe operation of the system). In addition—

(1) For direct current systems, an ammeter that can be switched into each generator feeder may be used; and

(2) If there is only one generator, the ammeter may be in the battery feeder.

(e) *External power.* If provisions are made for connecting external power to the rotorcraft, and that external power can be electrically connected to equipment other than that used for engine starting, means must be provided to ensure that no external power supply having a reverse polarity, or a reverse phase sequence, can supply power to the rotorcraft's electrical system.

(Amdt. 27–11, Eff. 2/1/77); (Amdt. 27–13, Eff. 9/1/77)

§ 27.1353 Storage battery design and installation.

(a) Each storage battery must be designed and installed as prescribed in this section.

(b) Safe cell temperatures and pressures must be maintained during any probable charging and discharging condition. No uncontrolled increase in cell temperature may result when the battery is recharged (after previous complete discharge)—

(1) At maximum regulated voltage or power;

(2) During a flight of maximum duration; and

(3) Under the most adverse cooling condition likely to occur in service.

(c) Compliance with paragraph (b) of this section must be shown by test unless experience with similar batteries and installations has shown that maintaining safe cell temperatures and pressures presents no problem.

(d) No explosive or toxic gases emitted by any battery in normal operation, or as the result of any probable malfunction in the charging system or battery installation, may accumulate in hazardous quantities within the rotorcraft.

of the battery or of its individual cells.

(g) Nickel cadmium battery installations capable of being used to start an engine or auxiliary power unit must have—

(1) A system to control the charging rate of the battery automatically so as to prevent battery overheating;

(2) A battery temperature sensing and over-temperature warning system with a means for disconnecting the battery from its charging source in the event of an over-temperature condition; or

(3) A battery failure sensing and warning system with a means for disconnecting the battery from its charging source in the event of battery failure.

(Amdt. 27–13, Eff. 9/1/77); (Amdt. 27–14, Eff. 3/1/78)

§ 27.1357 Circuit protective devices.

(a) Protective devices, such as fuses or circuit breakers, must be installed in each electrical circuit other than—

(1) The main circuits of starter motors; and

(2) Circuits in which no hazard is presented by their omission.

(b) A protective device for a circuit essential to flight safety may not be used to protect any other circuit.

(c) Each resettable circuit protective device (''trip free'' device in which the tripping mechanism cannot be overridden by the operating control) must be designed so that—

(1) A manual operation is required to restore service after tripping; and

(2) If an overload or circuit fault exists, the device will open the circuit regardless of the position of the operating control.

(d) If the ability to reset a circuit breaker or replace a fuse is essential to safety in flight, that circuit breaker or fuse must be located and identified so that it can be readily reset or replaced in flight.

tion must be adjacent to the sources controlled by the switch.

(b) Load circuits may be connected so that they remain energized after the switch is opened, if they are protected by circuit protective devices, rated at 5 amperes or less, adjacent to the electric power source.

(c) The master switch or its controls must be installed so that the switch is easily discernible and accessible to a crewmember in flight.

§ 27.1365 Electric cables.

(a) Each electric connecting cable must be of adequate capacity.

(b) Each cable that would overheat in the event of circuit overload or fault must be at least flame resistant and may not emit dangerous quantities of toxic fumes.

§ 27.1367 Switches.

Each switch must be—

(a) Able to carry its rated current;

(b) Accessible to the crew; and

(c) Labeled as to operation and the circuit controlled.

LIGHTS

§ 27.1381 Instrument lights.

The instrument lights must—

(a) Make each instrument, switch and other devices for which they are provided easily readable; and

(b) Be installed so that—

(1) Their direct rays are shielded from the pilot's eyes; and

(2) No objectionable reflections are visible to the pilot.

§ 27.1383 Landing lights.

(a) Each required landing or hovering light must be approved.

(1) For each separately installed landing light; and

(2) For each group of landing lights installed at a common location.

§ 27.1385 Position light system installation.

(a) *General.* Each part of each position light system must meet the applicable requirements of this section, and each system as a whole must meet the requirements of §§ 27.1387 through 27.1397.

(b) *Forward position lights.* Forward position lights must consist of a red and a green light spaced laterally as far apart as practicable and installed forward on the rotorcraft so that, with the rotorcraft in the normal flying position, the red light is on the left side and the green light is on the right side. Each light must be approved.

(c) *Rear position light.* The rear position light must be a white light mounted as far aft as practicable, and must be approved.

(d) *Circuit.* The two forward position lights and the rear position light must make a single circuit.

(e) *Light covers and color filters.* Each light cover or color filter must be at least flame resistant and may not change color or shape or lose any appreciable light transmission during normal use.

§ 27.1387 Position light system dihedral angles.

(a) Except as provided in paragraph (e) of this section, each forward and rear position light must, as installed, show unbroken light within the dihedral angles described in this section.

(b) Dihedral angle *L* (left) is formed by two intersecting vertical planes, the first parallel to the longitudinal axis of the rotorcraft, and the other at 110° to the left of the first, as viewed when looking forward along the longitudinal axis.

(c) Dihedral angle *R* (right) is formed by two intersecting vertical planes, the first parallel to the longitudinal axis of the rotorcraft, and the other at 110° to the right of the first, as viewed when looking forward along the longitudinal axis.

(d) Dihedral angle *A* (aft) is formed by two intersecting vertical planes making angles of 70° to the

allowable within that dihedral angle, if such solid angle is within a cone whose apex is at the rear position light and whose elements make an angle of 30° with a vertical line passing through the rear position light.

(Amdt. 27–7, Eff. 11/5/71)

§ 27.1389 Position light distribution and intensities.

(a) *General.* The intensities prescribed in this section must be provided by new equipment with light covers and color filters in place. Intensities must be determined with the light source operating at a steady value equal to the average luminous output of the source at the normal operating voltage of the rotorcraft. The light distribution and intensity of each position light must meet the requirements of paragraph (b) of this section.

(b) *Forward and rear position lights.* The light distribution and intensities of forward and rear position lights must be expressed in terms of minimum intensities in the horizontal plane, minimum intensities in any vertical plane, and maximum intensities in overlapping beams, within dihedral angles *L*, *R*, and *A*, and must meet the following requirements:

(1) *Intensities in the horizontal plane.* Each intensity in the horizontal plane (the plane containing the longitudinal axis of the rotorcraft and perpendicular to the plane of symmetry of the rotorcraft) must equal or exceed the values in § 27.1391.

(2) *Intensities in any vertical plane.* Each intensity in any vertical plane (the plane perpendicular to the horizontal plane) must equal or exceed the appropriate value in § 27.1393, where *I* is the minimum intensity prescribed in § 27.1391 for the corresponding angles in the horizontal plane.

(3) *Intensities in overlaps between adjacent signals.* No intensity in any overlap between adjacent signals may exceed the values in § 27.1395, except that higher intensities in overlaps may be used with main beam intensities substantially greater than the minima specified in §§ 27.1391 and 27.1393, if the overlap intensity.

§ 27.1391 Minimum intensities in the horizontal plane of forward and rear position lights.

Each position light intensity must equal or exceed the applicable values in the following table:

Dihedral angle (light included)	*Angle from right or left of longitudinal axis, measured from dead ahead*	*Intensity (candles)*
L and *R* (forward red and green)..	0° to 10°	40
	10° to 20°	30
	20° to 110°	5
A (rear white)	110° to180°	20

§ 27.1393 Minimum intensities in any vertical plane of forward and rear position lights.

Each position light intensity must equal or exceed the applicable values in the following table:

Angle above or below the horizontal plane:	*Intensity*
0°	1.00*I*.
0° to 5°	0.90*I*.
5° to 10°	0.80*I*.
10° to 15°	0.70*I*.
15° to 20°	0.50*I*.
20° to 30°	0.30*I*.
30° to 40°	0.10*I*.
40° to 90°	0.05*I*.

§ 27.1395 Maximum intensities in overlapping beams of forward and rear position lights.

No position light intensity may exceed the applicable values in the following table, except as provided in § 27.1389(b)(3).

Overlaps	*Maximum intensity*	
	Area A (candles)	*Area B (candles)*
Green in dihedral angle *L*	10	1
Red in dihedral angle *R*	10	1

(a) Area A includes all directions in the adjacent dihedral angle that pass through the light source and intersect the common boundary plane at more than 10° but less than 20°, and

(b) Area B includes all directions in the adjacent dihedral angle that pass through the light source and intersect the common boundary plane at more than 20°.

§ 27.1397 Color specifications.

Each position light color must have the applicable International Commission on Illumination chromaticity coordinates as follows:

(a) *Aviation red*—

"y" is not greater than 0.335; and

"z" is not greater than 0.002.

(b) *Aviation green*—

"x" is not greater than 0.440–0.320y;

"x" is not greater than y–0.170; and

"y" is not less than 0.390–0.170x.

(c) *Aviation white*—

"x" is not less than 0.300 and not greater than 0.540;

"y" is not less than "x–0.040" or "y_c–0.010" whichever is the smaller; and

"y" is not greater than "x+0.020" nor "0.636–0.400x";

Where "y_c is the "y" coordinate of the Planckian radiator for the value of "x" considered.

(Amdt. 27–6, Eff. 8/11/71)

§ 27.1399 Riding light.

(a) Each riding light required for water operation must be installed so that it can—

(1) Show a white light for at least two nautical miles at night under clear atmospheric conditions; and

(2) Show a maximum practicable unbroken light with the rotorcraft on the water.

(b) Externally hung lights may be used.

(Amdt. 27–2, Eff. 2/25/68)

§ 27.1401 Anticollision light system.

(a) *General.* If certification for night operation is requested, the rotorcraft must have an anticollision light system that—

and flight characteristics of the rotorcraft. The field of coverage must extend in each direction within at least 30° above and 30° below the horizontal plane of the rotorcraft, except that there may be solid angles of obstructed visibility totaling not more than 0.5 steradians.

(c) *Flashing characteristics.* The arrangement of the system, that is, the number of light sources, beam width, speed of rotation, and other characteristics, must give an effective flash frequency of not less than 40, nor more than 100, cycles per minute. The effective flash frequency is the frequency at which the rotorcraft's complete anticollision light system is observed from a distance, and applies to each sector of light including any overlaps that exist when the system consists of more than one light source. In overlaps, flash frequencies may exceed 100, but not 180, cycles per minute.

(d) *Color.* Each anticollision light must be aviation red and must meet the applicable requirements of § 29.1397.

(e) *Light intensity.* The minimum light intensities in any vertical plane, measured with the red filter (if used) and expressed in terms of "effective" intensities, must meet the requirements of paragraph (f) of this section. The following relation must be assumed:

$$I_e = \frac{\int_{t_1}^{t_2} I(t)dt}{0.2 + (t_2 - t_1)}$$

Where—

I_e=effective intensity (candles).

$I(t)$=instantaneous intensity as a function of time.

t_2–t_1=flash time interval (seconds).

Normally, the maximum value of effective intensity is obtained when t_2 and t_1, are chosen so that the effective intensity is equal to the instantaneous intensity at t_2 and t_1.

(f) *Minimum effective intensities for anticollision light.* Each anticollision light effective intensity must equal or exceed the applicable values in the following table:

SAFETY EQUIPMENT

§ 27.1411 General.

(a) Required safety equipment to be used by the crew in an emergency, such as flares and automatic liferaft releases, must be readily accessible.

(b) Stowage provisions for required safety equipment must be furnished and must—

(1) Be arranged so that the equipment is directly accessible and its location is obvious; and

(2) Protect the safety equipment from damage caused by being subjected to the inertia loads specified in § 27.561.

(Amdt. 27–11, Eff. 2/1/77)

§ 27.1413 Safety belts.

[Each safety belt must be equipped with a metal to metal latching device.]

(Amdt. 27–15, Eff. 12/4/78); (Amdt. 27–21, Eff. 12/6/84)

§ 27.1415 Ditching equipment.

(a) Emergency flotation and signaling equipment required by any operating rule in this chapter must meet the requirements of this section.

(b) Each raft and each life preserver must be approved and must be installed so that it is readily available to the crew and passengers. The storage provisions for life preservers must accommodate one life preserver for each occupant for which certification for ditching is requested.

(c) Each raft released automatically or by the pilot must be attached to the rotorcraft by a line to keep it alongside the rotorcraft. This line must be weak enough to break before submerging the empty raft to which it is attached.

(d) Each signaling device must be free from hazard in its operation and must be installed in an accessible location.

(Amdt. 27–11, Eff. 2/1/77)

within the rotorcraft altitude envelope. An analysis must be performed to establish, on the basis of the rotorcraft's operational needs, the adequacy of the ice protection system for the various components of the rotorcraft.

(c) In addition to the analysis and physical evaluation prescribed in paragraph (b) of this section, the effectiveness of the ice protection system and its components must be shown by flight tests of the rotorcraft or its components in measured atmospheric icing conditions and by one or more of the following tests as found necessary to determine the adequacy of the ice protection system:

(1) Laboratory dry air or simulated icing tests, or a combination of both, of the components or models of the components.

(2) Flight dry air tests of the ice protection system as a whole, or its individual components.

(3) Flight tests of the rotorcraft or its components in measured simulated icing conditions.

(d) The ice protection provisions of this section are considered to be applicable primarily to the airframe. Powerplant installation requirements are contained in subpart E of this part.

(e) A means must be identified or provided for determining the formation of ice on critical parts of the rotorcraft. Unless otherwise restricted, the means must be available for nighttime as well as daytime operation. The rotorcraft flight manual must describe the means of determining ice formation and must contain information necessary for safe operation of the rotorcraft in icing conditions.

(Amdt. 27–19, Eff. 3/2/83)

§ 27.1435 Hydraulic systems.

(a) *Design.* Each hydraulic system and its elements must withstand, without yielding, any structural loads expected in addition to hydraulic loads.

(b) *Tests.* Each system must be substantiated by proof pressure tests. When proof tested, no part of any system may fail, malfunction, or experience a permanent set. The proof load of each system must be at least 1.5 times the maximum operating pressure of that system.

and must be installed so that it will record the following:

[(1) Voice communications transmitted from or received in the rotorcraft by radio.

[(2) Voice communications of flight crewmembers on the flight deck.

[(3) Voice communications of flight crewmembers on the flight deck, using the rotorcraft's interphone system.

[(4) Voice or audio signals identifying navigation or approach aids introduced into a headset or speaker.

[(5) Voice communications of flight crewmembers using the passenger loudspeaker system, if there is such a system, and if the fourth channel is available in accordance with the requirements of paragraph (c)(4)(ii) of this section.

[(b) The recording requirements of paragraph (a)(2) of this section may be met—

[(1) By installing a cockpit-mounted area microphone located in the best position for recording voice communications originating at the first and second pilot stations and voice communications of other crewmembers on the flight deck when directed to those stations; or

[(2) By installing a continually energized or voice-actuated lip microphone at the first and second pilot stations. The microphone specified in this paragraph must be so located and, if necessary, the preamplifiers and filters of the recorder must be adjusted or supplemented so that the recorded communications are intelligible when recorded under flight cockpit noise conditions and played back. The level of intelligibility must be approved by the Administrator. Repeated aural or visual playback of the record may be used in evaluating intelligibility.

[(c) Each cockpit voice recorder must be installed so that the part of the communication or audio signals specified in paragraph (a) of this section obtained from each of the following sources is recorded on a separate channel:

[(1) For the first channel, from each microphone, headset, or speaker used at the first pilot station.

[(2) Each microphone, headset, or speaker used at the stations for the third and fourth crewmembers; or

[(ii) If the stations specified in paragraph (c)(4)(i) of this section are not required or if the signal at such a station is picked up by another channel, each microphone on the flight deck that is used with the passenger loudspeaker system if its signals are not picked up by another channel.

[(iii) Each microphone on the flight deck that is used with the rotorcraft's loudspeaker system if its signals are not picked up by another channel.

[(d) Each cockpit voice recorder must be installed so that—

[(1) It receives its electric power from the bus that provides the maximum reliability for operation of the cockpit voice recorder without jeopardizing service to essential or emergency loads;

[(2) There is an automatic means to simultaneously stop the recorder and prevent each erasure feature from functioning, within 10 minutes after crash impact; and

[(3) There is aural or visual means for preflight checking of the recorder for proper operation.

[(e) The record container must be located and mounted to minimize the probability of rupture of the container as a result of crash impact and consequent heat damage to the record from fire.

[(f) If the cockpit voice recorder has a bulk erasure device, the installation must be designed to minimize the probability of inadvertent operation and actuation of the device during crash impact.

[(g) Each recorder container must be either bright orange or bright yellow.]

(Amdt. 27–22, Eff. 10/11/88)

27.1459 Flight recorders.

(a) Each flight recorder required by the operating rules of Subchapter G of this chapter must be installed so that:

operation of the flight recorder without jeopardizing service to essential or emergency loads;

(4) There is an aural or visual means for preflight checking of the recorder for proper recording of data in the storage medium;

(5) Except for recorders powered solely by the engine-driven electrical generator system, there is an automatic means to simultaneously stop a recorder that has a data erasure feature and prevent each erasure feature from functioning, within 10 minutes after any crash impact; and

(b) Each nonejectable recorder container must be located and mounted so as to minimize the probability of container rupture resulting from crash impact and subsequent damage to the record from fire.

(c) A correlation must be established between the flight recorder readings of airspeed, altitude, and heading and the corresponding readings (taking into account correction factors) of the first pilot's instruments. This correlation must cover the airspeed range over which the aircraft is to be operated, the range of altitude to which the aircraft is limited, and 360 degrees of heading. Correlation may be established on the ground as appropriate.

(d) Each recorder container must:

(Amdt. 27-22, Eff. 10/11/88)

§ 27.1461 Equipment containing high energy rotors.

(a) Equipment containing high energy rotors must meet paragraph (b), (c), or (d) of this section.

(b) High energy rotors contained in equipment must be able to withstand damage caused by malfunctions, vibration, abnormal speeds, and abnormal temperatures. In addition—

(1) Auxiliary rotor cases must be able to contain damage caused by the failure of high energy rotor blades; and

(2) Equipment control devices, systems, and instrumentation must reasonably ensure that no operating limitations affecting the integrity of high energy rotors will be exceeded in service.

(c) It must be shown by test that equipment containing high energy rotors can contain any failure of a high energy rotor that occurs at the highest speed obtainable with the normal speed control devices inoperative.

(d) Equipment containing high energy rotors must be located where rotor failure will neither endanger the occupants nor adversely affect continued safe flight.

(Amdt. 27–2, Eff. 2/25/68)

(a) Each operating limitation specified in §§ 27.1503 through 27.1525 and other limitations and information necessary for safe operation must be established.

(b) The operating limitations and other information necessary for safe operation must be made available to the crewmembers as prescribed in §§ 27.1541 through 27.1589.

(Amdt. 27–8, Eff. 10/23/72); (Amdt. 27–14, Eff. 3/1/78)

OPERATING LIMITATIONS

§ 27.1503 Airspeed limitations: General.

(a) An operating speed range must be established.

(b) When airspeed limitations are a function of weight, weight distribution, altitude, rotor speed, power, or other factors, airspeed limitations corresponding with the critical combinations of these factors must be established.

§ 27.1505 Never-exceed speed.

(a) The never-exceed speed, V_{NE}, must be established so that it is—

(1) Not less than 40 knots (GAS); and

(2) Not more than the lesser of—

(i) 0.9 times the maximum forward speeds established under § 27.309;

(ii) 0.9 times the maximum speed shown under §§ 27.251 and 27.629; or

(iii) 0.9 times the maximum speed substantiated for advancing blade tip mach number effects.

(b) V_{NE} may vary with altitude, r.p.m., temperature, and weight, if—

(1) No more than two of these variables (or no more than two instruments integrating more than one of these variables) are used at one time; and

(2) The ranges of these variables (or of the indications on instruments integrating more than one of these variables) are large enough to allow V_{NE}.

(c) For helicopters, a stabilized power-off V_{NE} denoted as V_{NE} (power-off) may be established at a speed less than V_{NE} established pursuant to paragraph (a) of this section, if the following conditions are met:

(1) V_{NE} (power-off) is not less than a speed midway between the power-on V_{NE} and the speed used in meeting the requirements of—

(i) § 27.65(b) for single engine helicopters; and

(ii) § 27.67 for multiengine helicopters.

(2) V_{NE} (power-off) is—

(i) A constant airspeed;

(ii) A constant amount less than power-on V_{NE}; or

(iii) A constant airspeed for a portion of the altitude range for which certification is requested, and a constant amount less than power-on V_{NE} for the remainder of the altitude range.

(Amdt. 27–2, Eff. 2/25/68); (Amdt. 27–14, Eff. 3/1/78); (Amdt. 27–21, Eff. 12/6/84)

§ 27.1509 Rotor speed.

(a) *Maximum power off (autorotation).* The maximum power-off rotor speed must be established so that it does not exceed 95 percent of the lesser of—

(1) The maximum design r.p.m. determined under § 27.309(b); and

(2) The maximum r.p.m. shown during the type tests.

(b) *Minimum power off.* The minimum power-off rotor speed must be established so that it is not less than 105 percent of the greater of—

(1) The minimum shown during the type tests; and

(2) The minimum determined by design substantiation.

(c) *Minimum power on.* The minimum power-on rotor speed must be established so that it is—

(1) Not less than the greater of—

The weight and center of gravity limitations determined under §§ 27.25 and 27.27, respectively, must be established as operating limitations.

(Amdt. 27–2, Eff. 2/25/68); (Amdt. 27–21, Eff. 12/6/84)

§ 27.1521 Powerplant limitations.

(a) *General.* The powerplant limitations prescribed in this section must be established so that they do not exceed the corresponding limits for which the engines are type certificated.

(b) *Takeoff operation.* The powerplant takeoff operation must be limited by—

(1) The maximum rotational speed, which may not be greater than—

(i) The maximum value determined by the rotor design; or

(ii) The maximum value shown during the type tests;

(2) The maximum allowable manifold pressure (for reciprocating engines);

(3) The time limit for the use of the power corresponding to the limitations established in paragraphs (b)(1) and (2) of this section;

(4) If the time limit in paragraph (b)(3) of this section exceeds two minutes, the maximum allowable cylinder head, coolant outlet, or oil temperatures;

(5) The gas temperature limits for turbine engines over the range of operating and atmospheric conditions for which certification is requested.

(c) *Continuous operation.* The continuous operation must be limited by—

(1) The maximum rotational speed, which may not be greater than—

(i) The maximum value determined by the rotor design; or

(ii) The maximum value shown during the type tests;

(2) The minimum rotational speed shown under the rotor speed requirements in § 27.1509(c); and

(3) The gas temperature limits for turbine engines over the range of operating and main rotors driven by turboshaft engines, and that do not have a torque limiting device in the transmission system, the following apply:

(1) A limit engine torque must be established if the maximum torque that the engine can exert is greater than—

(i) The torque that the rotor drive system is designed to transmit; or

(ii) The torque that the main rotor assembly is designed to withstand in showing compliance with § 27.547(e).

(2) The limit engine torque established under paragraph (e)(1) of this section may not exceed either torque specified in paragraph (e)(1) (i) or (ii) of this section.

(f) *Ambient temperature.* For turbine engines, ambient temperature limitations (including limitations for winterization installations, if applicable) must be established as the maximum ambient atmospheric temperature at which compliance with the cooling provisions of §§ 27.1041 through 27.1045 is shown.

(g) *Two and one-half-minute OEI power operation.* Unless otherwise authorized, the use of 2½-minute OEI power must be limited to engine failure operation of multiengine, turbine-powered rotorcraft for not longer that 2½ minutes after failure of an engine. The use of 2½-minute OEI power must also be limited by—

(1) The maximum rotational speed, which may not be greater than—

(i) The maximum value determined by the rotor design; or

(ii) The maximum demonstrated during the type tests;

(2) The maximum allowable gas temperature; and

(3) The maximum allowable torque.

(h) *Thirty-minute OEI power operation.* Unless otherwise authorized, the use of 30-minute OEI power must be limited to multiengine, turbine-powered rotorcraft for not longer than 30 minutes after failure of an engine. The use of 30-minute OEI power must also be limited by—

(i) *Continuous OEI power operation.* Unless otherwise authorized, the use of continuous OEI power must be limited to multiengine, turbine-powered rotorcraft for continued flight after failure of an engine. The use of continuous OEI power must also be limited by—

(1) The maximum rotational speed, which may not be greater than—

(i) The maximum value determined by the rotor design; or

(ii) The maximum value demonstrated during the type tests;

(2) The maximum allowable gas temperature; and

(3) The maximum allowable torque.

[(j) *Rated 30-second OEI power operation.* Rated 30-second OEI power is permitted only on multiengine, turbine-powered rotorcraft, also certificated for the use of rated 2-minute OEI power, and can only be used for continued operation of the remaining engine(s) after a failure or precautionary shutdown of an engine. It must be shown that following application of 30-second OEI power, any damage will be readily detectable by the applicable inspections and other related procedures furnished in accordance with section A27.4 of appendix A of this part and section A33.4 of appendix A of part 33. The use of 30-second OEI power must be limited to not more than 30 seconds for any period in which that power is used, and by—

[(1) The maximum rotational speed, which may not be greater than—

[(i) The maximum value determined by the rotor design; or

[(ii) The maximum value demonstrated during the type tests;

[(2) The maximum allowable gas temperature; and

[(3) The maximum allowable torque.

[(k) *Rated 2-minute OEI power operation.* Rated 2-minute OEI power is permitted only on multiengine, turbine-powered rotorcraft, also certificated for the use of rated 30-second OEI power, and can only be used for continued operation of the remaining engine(s) after a failure or precautionary shutdown of an engine. It must be shown that following application of 2-minute OEI power, any damage will be readily detectable by the applicable inspections and other related procedures furnished in accordance with section A27.4 of appendix A of this part and section A33.4 of appendix A of part 33. The use of 2-minute OEI power must be limited to not more than 2 minutes for any period in which that power is used, and by—

[(1) The maximum rotational speed, which may not be greater than—

[(i) The maximum value determined by the rotor design; or

[(ii) The maximum value demonstrated during the type tests;

[(2) The maximum allowable gas temperature; and

[(3) The maximum allowable torque.]

(Amdt. 27–14, Eff. 3/1/78); (Amdt. 27–23, Eff. 10/3/88); [(Amdt. 27–29, Eff. 10/17/94)]

§ 27.1523 Minimum flight crew.

The minimum flight crew must be established so that it is sufficient for safe operation, considering—

(a) The workload on individual crewmembers;

(b) The accessibility and ease of operation of necessary controls by the appropriate crewmember; and

(c) The kinds of operation authorized under § 27.1525.

§ 27.1525 Kinds of operation.

The kinds of operations (such as VFR, IFR, day, night, or icing) for which the rotorcraft is approved are established by demonstrated compliance with the applicable requirements and by the installed equipment.

(Amdt. 27–21, Eff. 12/6/84)

§ 27.1527 Maximum operating altitude.

The maximum altitude up to which operation is allowed, as limited byflight, structural, powerplant, functional, or equipment characteristics, must be established.

(Amdt. 27–14, Eff. 3/1/78)

§ 27.1529 Instructions for Continued Airworthiness.

The applicant must prepare Instructions for Continued Airworthiness in accordance with appen-

MARKINGS AND PLACARDS

§ 27.1541 General.

(a) The rotorcraft must contain—

(1) The markings and placards specified in §§ 27.1545 through 27.1565, and

(2) Any additional information, instrument markings, and placards required for the safe operation of rotorcraft with unusual design, operating or handling characteristics.

(b) Each marking and placard prescribed in paragraph (a) of this section—

(1) Must be displayed in a conspicuous place; and

(2) May not be easily erased, disfigured, or obscured.

§ 27.1543 Instrument markings: General.

For each instrument—

(a) When markings are on the cover glass of the instrument, there must be means to maintain the correct alignment of the glass cover with the face of the dial; and

(b) Each arc and line must be wide enough, and located, to be clearly visible to the pilot.

§ 27.1545 Airspeed indicator.

(a) Each airspeed indicator must be marked as specified in paragraph (b) of this section, with the marks located at the corresponding indicated airspeeds.

(b) The following markings must be made:

(1) A red radial line—

(i) For rotorcraft other than helicopters, at V_{NE}; and

(ii) For helicopters, at V_{NE} (power-on).

(2) A red, cross-hatched radial line at V_{NE} (power-off) for helicopters, if V_{NE} (power-off) is less than V_{NE} (power-on).

(3) For the caution range, a yellow arc.

(c) The placard must state whether the calibration was made with radio receivers on or off.

(d) Each calibration reading must be in terms of magnetic heading in not more than 45° increments.

(e) If a magnetic nonstabilized direction indicator can have a deviation of more than 10 degrees caused by the operation of electrical equipment, the placard must state which electrical loads, or combination of loads, would cause a deviation of more than 10 degrees when turned on.

(Amdt. 27–13, Eff. 9/1/77)

§ 27.1549 Powerplant instruments.

For each required powerplant instrument, as appropriate to the type of instrument—

(a) Each maximum and, if applicable, minimum safe operating limit must be marked with a red radial or a red line;

(b) Each normal operating range must be marked with a green arc or green line, not extending beyond the maximum and, minimum safe limits;

(c) Each takeoff and precautionary range must be marked with a yellow arc or yellow line;

(d) Each engine or propeller range that is restricted because of excessive vibration stresses must be marked with red arc or red lines; and

[(e) Each OEI limit or approved operating range must be marked to be clearly differentiated from the markings of paragraphs (a) through (d) of this section except that no marking is normally required for the 30-second OEI limit.]

(Amdt. 27–11, Eff. 2/1/77); (Amdt. 27–23, Eff. 10/3/88); [(Amdt. 27–29, Eff. 10/17/94)]

§ 27.1551 Oil quantity indicator.

Each oil quantity indicator must be marked with enough increments to indicate readily and accurately the quantity of oil.

(a) Each cockpit control, other than primary flight controls or control whose function is obvious, must be plainly marked as to its function and method of operation.

(b) For powerplant fuel controls—

(1) Each fuel tank selector control must be marked to indicate the position corresponding to each tank and to each existing cross feed position;

(2) If safe operation requires the use of any tanks in a specific sequence, that sequence must be marked on, or adjacent to, the selector for those tanks; and

(3) Each valve control for any engine of a multiengine rotorcraft must be marked to indicate the position corresponding to each engine controlled.

(c) Usable fuel capacity must be marked as follows:

(1) For fuel systems having no selector controls, the usable fuel capacity of the system must be indicated at the fuel quantity indicator.

(2) For fuel systems having selector controls, the usable fuel capacity available at each selector control position must be indicated near the selector control.

(d) For accessory, auxiliary, and emergency controls—

(1) Each essential visual position indicator, such as those showing rotor pitch or landing gear position, must be marked so that each crewmember can determine at any time the position of the unit to which it relates; and

(2) Each emergency control must be red and must be marked as to method of operation.

(e) For rotorcraft incorporating retractable landing gear, the maximum landing gear operating speed must be displayed in clear view of the pilot.

(Amdt. 27–11, Eff. 2/1/77); (Amdt. 27–21, Eff. 12/6/84)

nently attached to the seat structure.

(c) *Fuel and oil filler openings.* The following apply:

(1) Fuel filler openings must be marked at or near the filler cover with—

(i) The word "fuel";

(ii) For reciprocating engine powered rotorcraft, the minimum fuel grade;

(iii) For turbine engine powered rotorcraft, the permissible fuel designations; and

(iv) For pressure fueling systems, the maximum permissible fueling supply pressure and the maximum permissible defueling pressure.

(2) Oil filler openings must be marked at or near the filler cover with the word "oil".

(d) *Emergency exit placards.* Each placard and operating control for each emergency exit must be red. A placard must be near each emergency exit control and must clearly indicate the location of that exit and its method of operation.

(Amdt. 27–11, Eff. 2/1/77)

§ 27.1559 Limitations placard.

There must be a placard in clear view of the pilot that specifies the kinds of operations (such as VFR, IFR, day, night, or icing) for which the rotorcraft is approved.

(Amdt. 27–3, Eff. 10/17/68); (Amdt. 27–8, Eff. 10/23/72); (Amdt. 27–21, Eff. 12/6/84)

§ 27.1561 Safety equipment.

(a) Each safety equipment control to be operated by the crew in emergency, such as controls for automatic liferaft releases, must be plainly marked as to its method of operation.

(b) Each location, such as a locker or compartment, that carries any fire extinguishing, signaling, or other life saving equipment, must be so marked.

§ 27.1581 General.

(a) *Furnishing information.* A Rotorcraft Flight Manual must be furnished with each rotorcraft, and it must contain the following:

(1) Information required by §§ 27.1583 through 27.1589.

(2) Other information that is necessary for safe operation because of design, operating, or handling characteristics.

(b) *Approved information.* Each part of the manual listed in §§ 27.1583 through 27.1589, that is appropriate to the rotorcraft, must be furnished, verified, and approved, and must be segregated, identified, and clearly distinguished from each unapproved part of that manual.

(c) [Reserved]

(d) *Table of contents.* Each Rotorcraft Flight Manual must include a table of contents if the complexity of the manual indicates a need for it.

(Amdt. 27–8, Eff. 10/23/72); (Amdt. 27–14, Eff. 3/1/78)

§ 27.1583 Operating limitations.

(a) *Airspeed and rotor limitations.* Information necessary for the marking of airspeed and rotor limitations on, or near, their respective indicators must be furnished. The significance of each limitation and of the color coding must be explained.

(b) *Powerplant limitations.* The following information must be furnished:

(1) Limitations required by § 27.1521.

(2) Explanation of the limitations, when appropriate.

(3) Information necessary for marking the instruments required by §§ 27.1549 through 27.1553.

(c) *Weight and loading distribution.* The weight and center of gravity limits required by §§ 27.25 and 27.27, respectively, must be furnished. If the variety of possible loading conditions warrants, instructions must be included to allow ready observance of the limitations.

tors must be furnished.

(Amdt. 27–2, Eff. 2/25/68); (Amdt. 27–14, Eff. 3/1/78); (Amdt. 27–16, Eff. 12/1/78)

§ 27.1585 Operating procedures.

(a) Parts of the manual containing operating procedures must have information concerning any normal and emergency procedures and other information necessary for safe operation, including takeoff and landing procedures and associated airspeeds. The manual must contain any pertinent information including—

(1) The kind of takeoff surface used in the tests and each appropriate climbout speed; and

(2) The kind of landing surface used in the tests and appropriate approach and glide airspeeds.

(b) For multiengine rotorcraft, information identifying each operating condition in which the fuel system independence prescribed in § 27.953 is necessary for safety must be furnished, together with instructions for placing the fuel system in a configuration used to show compliance with that section.

(c) For helicopters for which a V_{NE} (power-off) is established under § 27.1505(c), information must be funished to explain the V_{NE} (power-off) and the procedures for reducing airspeed to not more than the V_{NE} (power-off) following failure of all engines.

(d) For each rotorcraft showing compliance with § 27.1353 (g)(2) or (g)(3), the operating procedures for disconnecting the battery from its charging source must be furnished.

(e) If the unusable fuel supply in any tank exceeds five percent of the tank capacity, or one gallon, whichever is greater, information must be furnished which indicates that when the fuel quantity indicator reads ''zero'' in level flight, any fuel remaining in the fuel tank cannot be used safely in flight.

(f) Information on the total quantity of usable fuel for each fuel tank must be furnished.

with §§ 27.51 through 27.79 and 27.143(c):

(1) Enough information to determine the limiting height-speed envelope.

(2) information relative to—

(i) The hovering ceilings and the steady rates of climb and descent, as affected by any pertinent factors such as airspeed, temperature, and altitude;

(ii) The maximum safe wind for operation near the ground. If there are combinations of weight, altitude, and temperature for which performance information is provided and at which the rotorcraft cannot land and takeoff safely with the maximum wind value, those portions of the operating envelope and the appropriate safe wind conditions shall be identified in the flight manual;

(1) In its performance information section any pertinent information concerning the takeoff weights and altitudes used in compliance with § 27.51; and

(2) The horizontal takeoff distance determined in accordance with § 27.65(a)(2)(i).

(Amdt. 27–14, Eff. 3/1/78); (Amdt. 27–21, Eff. 12/6/84)

§ 27.1589 Loading information.

There must be loading instructions for each possible loading condition between the maximum and minimum weights determined under § 27.25 that can result in a center of gravity beyond any extreme prescribed in § 27.27, assuming any probable occupant weights.